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SPACE SHUTTLE

AERОTHERMODYNAMIC DATA REPORT

JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANagement services

SPACE DIVISION CHRYSLER CORPORATION

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VOLUME 1 OF 3

HEAT TRANSFER TESTS ON A 0.01-SCALE ROCKWELL CONFIGURATION 3 SPACE SHUTTLE ORBITER AND TANK (37-OT) IN THE CALSPAN 48-INCH HYPERSONIC SHOCK TUNNEL (OH12/IH21)

by

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Prepared under NASA Contract Number NAS9-13247

by

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Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number:	Calspan 48 HST-173-100
NASA Series Number:	OH12/IH21
Model Number:	37-OT
Test Dates:	October 29 through December 15, 1973

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HEAT TRANSFER TESTS ON A 0.01-SCALE ROCKWELL CONFIGURATION 3 SPACE SHUTTLE ORBITER AND TANK (37-OT) IN THE CALSPAN 48-INCH HYPERSONIC SHOCK TUNNEL (OH12/IH21)

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M. Kotch, Rockwell International Space Division

ABSTRACT

This report presents model information and data from wind tunnel tests conducted on 0.01-scale models of the Rockwell Space Shuttle Orbiter and External Tank. These tests were conducted in the Calspan 48" Hypersonic Shock Tunnel to determine heating rates on ascent and re-entry configurations at various Reynolds numbers, Mach numbers and angles of attack.

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INTRODUCTION

A 0.01-scale orbiter/external tank heat transfer model (number 37-OT) was tested in the Calspan 48" Hypersonic Shock Tunnel from October 29 through December 15, 1973. The NASA/Rockwell designation for this test was OH12/IH21, and the Calspan facility test number was I73-100.

The purpose of this test was to determine ascent and entry heat transfer rates for the external tank and the Configuration 3 Orbiter over a range of Mach numbers from 6.95 to 19.5 and Reynolds numbers/foot from 0.0095×10^6 to 6.5×10^6. Of particular interest was the determination of orbiter wing leading edge heating during entry, with both laminar and turbulent boundary layer conditions.

A total of 58 good program runs was made out of 73 attempts. Fifteen runs were no good because of facility malfunction or off scale heating rate data. This test is also documented in Reference 2 (a Calspan Technical Report).

NOMENCLATURE

Symbol	Plot Symbol	Definition
b	B	wing span, inches
c	C	local wing chord, inches
C_h		Stanton number $\frac{778\ q_w}{\rho_\infty U_\infty (rH_o - H_w)}$
h	H	heat-transfer coefficient, 778 (32.17) $\dot{q}/(rH_o - H_w)$, lbm/ft^2 sec
H		Enthalpy, ft. lbs/slug
L	L	fuselage length, inches
M	MACH	Mach number
OMS		Orbital Maneuvering System
P	P	Pressure, psia
P_r		Prandtl number
q		Dynamic pressure, psia
$\dot{q}$	QDOT	heat transfer rate, BTU/ft^2 sec
RCS		reaction control system
r	HAW/HT	recovery factor
R_e/ft	RE/FT	Reynolds number per unit length, $\frac{\rho_\infty U_\infty}{\mu_\infty}$
S		wing span, inches
T	T	temperature, °R
t		time, seconds
U		velocity, ft/sec
X	X	longitudinal distance, inches
Y	Y	spanwise distance, inches

NOMENCLATURE (Continued)

Symbol	Plot Symbol	Definition
Z	Z	vertical distance, inches
α	ALPHA	angle of attack, degrees
β	BETA	angle of sideslip, degrees
γ		specific heat ratio
μ		absolute viscosity, slugs/ft-sec
ρ		density, slugs/ft^3
ϕ	PHI	Orbiter and external tank fuselage angular coordinate, deg. measured clockwise looking forward, 0 degrees at bottom centerline
o		nozzle supply conditions
o′		stagnation conditions behind a normal shock
1		initial driven gas condition
ms		model station
4		gas conditions behind reflected shock
i		incident shock in driven gas
ts		test section initial conditions
w		initial conditions at model surface
∞		free stream or test section conditions
H_{aw}	HAW	adiabatic wall enthalpy
H_t	HT	free stream total enthalpy

NOMENCLATURE (Concluded)

Symbol	Plot Symbol	Definition
h_{ref}	HREF	reference heat-transfer coefficient, value obtained at stagnation point on a one foot diameter sphere
h/h_{ref}	H/HREF	ratio of model heat-transfer coefficient to heat-transfer coefficient of reference sphere for H_{aw}/H_t = X.XXX
	HI/HU	interference to undisturbed heat transfer coefficient ratio
	X/C	chordwise location, fraction of local chord
	X/L	longitudinal location, fraction of body length
	2Y/B	spanwise location, fraction of semi-span
	Z/BV	spanwise location on vertical tail, fraction of exposed span
	RN/L	Reynolds number per unit length
	RN/L1, RN/L2, RN/L3	designates the Reynolds number schedule defined by table I

CONFIGURATIONS INVESTIGATED

Model 37-OT is a 0.01-scale model of the Space Shuttle configuration 3 Orbiter and external tank.constructed of 17-4 PH stainless steel. The orbiter is a sting mounted full-span model, with OMS/RCS pods. The external tank is equipped with removable protuberances (lines and attachment struts) and was mounted on a separate sting which was either coupled with the orbiter sting or mounted separately on the tunnel support fixture. The figures and photographs at the back of this text illustrate orbiter and external tank details. Model 37-OT was designed and built by Grumman Aerospace Corp. with instrumentation built and installed by Calspan Corporation.

Model nomenclature used for the configuration 3 Orbiter and external tank was as follows:

B_{17}	Orbiter body
C_7	Canopy
E_{22}	Elevon
F_5	Body flap
M_4	OMS pod
R_5	Rudder
T_{10}	External tank
T_{16}	External tank without protuberances
V_7	Vertical tail
W_{103}	Wing

Model dimensional data are given in Table III. Table II outlines model configurations and tunnel conditions investigated. The following configuration notation is used:

CONFIGURATIONS INVESTIGATED (Concluded)

O = Orbiter = B_{17} C_7 E_{22} F_5 M_4 R_5 V_7 W_{103}

T = external tank = T_{10}

T-NP = external tank without protuberances, support structure, or lines = T_{16}

MODEL INSTRUMENTATION

Model instrumentation for 37-OT consisted of 158 thin-film heat transfer gages. Ninety-eight (98) of these gages were on the orbiter, the remaining sixty (60) were on the external tank. Orbiter and tank gage locations are illustrated in figure 2 and tabulated in Table IV. Photographs in figure 3 may clarify questions about gauge locations.

The thin-film gages consisted of a platinum film fused to a pyrex insulating substrate and protected from the free stream by a thin dielectric coating of magnesium fluoride. Transient surface temperature is determined by measuring the instantaneous gage resistance change which varied linearly with temperature. An excellent description of thin-film gage theory and operation can be found in Reference 1.

Tunnel conditions were determined by quick-response pressure transducers and a reference stagnation heat-transfer gage.

Data acquisition equipment, provided by Calspan, consisted of the Calspan NAVCOR 48-channel data acquisition system, one 14-channel high-speed FM tape recorder, and twenty-two 2-channel recording oscilloscopes. The NAVCOR system provided both a temperature and heat-transfer rate history for each channel, while the oscilloscopes recorded only heat-transfer rate. This rate was derived from an analog network which converted the gage temperature signal to a heat transfer rate signal. The tape recorder was used only as a temporary storage of temperature histories and was input into the NAVCOR following each run for a record of temperature and heat transfer rate.

MODEL INSTRUMENTATION (Concluded)

Additional instrumentation consisted of a tunnel Schlieren photograph system, which provided qualitative flow information for each run. Sample Schlieren photographs are included in figure 3.

TEST FACILITY DESCRIPTION

The 48-inch Hypersonic Shock Tunnel (HST) employs a constant-area shock tube with an 8-inch inner diameter. The driver tube is 20 feet long and is externally heated by a resistance heater to temperatures of 1400° R. The driven tube is 50 feet long. The driver gas is generally a mixture of helium and nitrogen with a maximum helium purity of 100% while the driven gas is generally air. Steady-flow test times of duration sufficient to permit accurate measurement of the various parameters of interest are achieved with the tailored-interface technique.

Three axisymmetric nozzles are available to expand the test gas to high volocities:

Nozzle	Type	Exit Diameter in inches	Test Section Mach Number
A	Contoured	24	5.5 to 8
D	Contoured	48	10 to 16
E	10-1/2° Semi-angle cone	48	9 to 20

The contoured nozzles provide parallel flow with no pressure gradients in the streamwise direction for several feet. This is very important since the presence of a streamwise pressure gradient can have a significant effect on model test results. The nozzles employ replaceable throat inserts of different diameters so that with the particular nozzle, the test Mach number can be varied. Test air passes downstream of the test section into a receiver tank of a size sufficient to maintain the desired flow for durations of 5 to 13 milliseconds. All nozzles have been calibrated using pitot-pressure survey rakes over the Mach number range indicated.

TEST FACILITY DESCRIPTION (Concluded)

The Test Section is equipped with two 16-inch diameter Schlieren windows mounted a short distance aft of the nozzle exit.

TEST PROCEDURE

Model 37-OT was mounted via the model sting(s) to the tunnel support fixture at the tunnel centerline. Instrumentation wiring was routed through the base stings to a tunnel instrumentation patch panel. Figures 2a and b show the orbiter alone and the second stage configuration installations, respectively.

A typical test procedure was as follows:

1. Set model angles-of-attack, if necessary.
2. Install tunnel diaphrams and proper tunnel nozzle orifice.
3. Evacuate test section, set instrumentation gains and calibrate oscilloscopes from heating rate estimates, and check gage resistances for weak or damaged gages.
4. Close driver and load driven tube for proper test conditions. Take no-flow Schlieren picture.
5. Load driver to proper mixture and pressure for test conditions.
6. Fire tunnel for run.
7. Evacuate test section for post-run gage checks, then bring test section to atmosphere and break tunnel joints. Read out data.
8. Clean tunnel and inspect model.

DATA REDUCTION

Data for this test were reduced according to standard Calspan data reduction procedures. NAVCOR recordings and Polaroid film oscilloscope records of heat transfer rates were made available after each run. Following the test, all data records were read and assembled for computerized data reduction.

This report contains a listing of heat transfer coefficient H/HREF and heat transfer rate QDOT. H/HREF values are presented for three recovery factors r = .85, .9 and 1.0. Plotted data illustrate the effect of recovery factor, angle of attack and Reynolds number on heat transfer. The postscript on RN/L indicates the Reynolds number schedule defined by table I. Heat transfer changes between undisturbed and mated configurations is illustrated by HI/HU plots. The plotted and tabulated data are arranged in the following manner:

VOLUME NO.	CONTENTS
1	Plots showing the effect of recovery factor on orbiter and external tank heat transfer for both undisturbed and mated configurations. Figure 4 through Figure 17
2	Plots showing the effect of angle of attack and Reynolds number on the undisturbed orbiter heat transfer Figure 18 through Figure 35

DATA REDUCTION (Concluded)

VOLUME NO.			
3	Tabular listing of source data		
	H/HREF ~ heat transfer coefficient data		
	Component	Fourth Character*	Page
	orbiter fuselage	B	1
	orbiter wing	W	75
	orbiter vertical tail	V	180
	orbiter wing leading edge (see Detail A fig. 2b)	A	219
	orbiter wing leading edge (see Detail B fig. 2b)	C	254
	external tank	T	323
	QDOT ~ heat transfer rate is arranged in the same manner		365-512

* The fourth character in each dataset identifier (i.e., RUGBXX, B for Fuselage) represents the individual component.

REFERENCES

L. Vidal, R. J., "Model Instrumentation Techniques for Heat Transfer and Force Measurements in a Hypersonic Shock Tunnel," Cornell Aeronautical Laboratory Report No. AD-917-A-7, February, 1956.

2. Patten, J. S., "An Experimental Investigation of the Ascent and Descent Heating on a 0.01-Scale Model of the Space Shuttle," Calspan Technical Report, March, 1974.

3. Foust, J. W., "Pretest Information for Testing the 0.010-Scale Space Shuttle Heat Transfer Model 37-OT in the Calspan Hypersonic Shock Tunnel," SD73-SH-0198, dated July 11, 1973.

TABLE I.

TEST : OH-12, IH-21			DATE : 5/3/74

TEST CONDITIONS

MACH NUMBER	REYNOLDS NUMBER (per unit length) (1/ft)	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Rankine)
6.95	0.10×10^6	1.35	5575
7.6	1.19×10^6	2.75	2000
7.9	6.5×10^6	10.2	1550
8.0	1.19×10^6	3.22	2600
10.2	2.0×10^6	4.03	2725
10.5	0.86×10^6	2.71	3200
12.0(sch 1)	0.20×10^6	0.73	3925
12.0(sch 3)	0.86×10^6	0.26	3475
15.6(sch 1)	0.035×10^6	0.07	3650
15.6(sch 3)	0.20×10^6	0.36	3500
18.5	0.0095×10^6	0.017	4400
19.5	0.035×10^6	0.065	4650
15.6(sch 2)	0.3×10^6	0.61	3841

BALANCE UTILIZED: ______________________

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

TABLE II.

TEST: OH12 / IH21	DATA SET/RUN NUMBER COLLATION SUMMARY																		DATE: 6-18-75
DATA SET IDENTIFIER	CONFIGURATION	SCHD.		PARAMETERS/VALUES				NO. OF RUNS	MACH NUMBERS (OR ALTERNATE INDEPENDENT VARIABLE)										
		α	β	RN/L SCH		T/C HOOKUP			7.0	7.61	7.9	8.0	10.5	12.2	15.8		18.3*	19.1*	
RUG001	37T	0°	0	1		T		5	4	2					73		49	48	
02	↓	5				T		1										50	
03	37T-NP	0				T		1									51		
04	37 OT-NP	0				Φ/T		2									36/35		
05	37 OT	0				Φ/T		8	28/31	27/30							37/34	38/32	
06	↓	5				Φ/T		2										39/33	
07	37 O	0				Φ		5	5	8					52		42	41	
08		5						1										40	
09		10						1									43		
10		25						7	9		26	10	53	55	57			44	
11		30						7	12		14,25		63	61	62			46	
12		35						7	20		22	21	64	67	65			47	
13	↓	40		↓		↓		2			24	23							
14	37-OT	0		2		Φ/T		3							70/71,72				
15	37 O	25		3		Φ		2						54	56				
16		30						2						58	60				
17	↓	35	↓	↓		↓		2						68	66				

TEST RUN NUMBERS

1 7 13 19 25 31 37 43 49 55 61 67 75 76

COEFFICENTS IDVAR (1) IDVAR (2) NDV

α OR β SCHEDULES

NP denotes ET without protuberances

* Nominal Values - check individual runs for Values

Table III Model Dimensional Data

MODEL COMPONENT : BODY - B_{17}

GENERAL DESCRIPTION : Fuselage, 3 configuration, lightweight orbiter

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length , In.	1290.3	12.903
Max Width , In.	267.6	2.676
Max Depth, In.	244.5	2.445
Fineness Ratio	4.822	4.822
Area - Ft^2		
Max. Cross-Sectional	386.67	3.867
Planform		
Wetted		
Base		

DM3 014

Table III (Cont'd)

MODEL COMPONENT : CANOPY - C_7

GENERAL DESCRIPTION : Configuration 3

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (X_o =433 to X_o =578), In.	145.00	1.450
Max Width		
Max Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

DMS 011

Table III (Cont'd)

MODEL COMPONENT: ELEVON - E_{22}

GENERAL DESCRIPTION: Configuration 3. Data for 1 of 2 sides.

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000139

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Area - Ft^2	205.52	0.0206
Span (equivalent), In.	353.34	3.533
Inb'd equivalent chord, In.	114.78	1.148
Outb'd equivalent chord, In.	55.00	0.550
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.208	0.208
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	0.00	0.00
Tailing Edge	-10.24	-10.24
Hingeline	0.00	0.00
Area Moment (Product of area & $\bar{c}$) (~~Normal to Hinge Line~~), Ft^3	1548.07	0.0015

Table III (Cont'd)

MODEL COMPONENT : BODY FLAP - F_5

GENERAL DESCRIPTION : Configuration 3

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length , In.	84.70	0.847
Max Width , In.	267.6	2.676
Max Depth		
Fineness Ratio		
Area - Ft^2		
Max. Cross-Sectional		
Planform	142.5	0.014
Wetted		
Base	38.096	0.0038

DM3 014

Table III. (Cont'd)

MODEL COMPONENT : OMS POD - M_4

GENERAL DESCRIPTION : Configuration 3

NOTE: Identical to M_3, except inte section to fuselage.

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length , In.	346.0	3.460
Max Width , In.	108.0	1.080
Max Depth , In.	113.0	1.130
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

Table III (Cont'd)

MODEL COMPONENT: RUDDER - R_5

GENERAL DESCRIPTION: Configuration 2A, 3, 3A and 140A/B

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000146A, -000095, -000139

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	100.15	0.0100
Span (equivalent), In.	201.0	2.010
Inb'd equivalent chord, In.	91.585	0.916
Outb'd equivalent chord, In.	50.833	0.508
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	34.83	34.83
Tailing Edge	26.25	26.25
Hingeline	34.83	34.83
Area Moment (~~Normal to hinge line~~) (Product of area & $\bar{c}$), Ft^3	610.92	0.0006
Mean Aerodynamic Chord, In.	73.2	0.732

Table III (Cont'd)

MODEL COMPONENT : EXTERNAL TANK - T_{10}

GENERAL DESCRIPTION : External oxygen-hydrogen tank, configuration 3

MODEL SCALE: 0.010

DRAWING NUMBER : VL72-000088, VL78-000041

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (Nose at X_T = 309)	1865.0	18.650
Max Width (Dia.), In.	324.00	3.240
Max Depth		
Fineness Ratio	5.756	5.756
Area - Ft^2		
Max. Cross-Sectional	572.555	0.057
Planform		
Wetted		
Base		
W.P. of Tank Centerline (X_T), In.	400.0	4.00

DM3 016

Table III (Cont'd)

MODEL COMPONENT : EXTERNAL TANK - T_{16}

GENERAL DESCRIPTION : External oxygen-hydrogen tank. Has a 2416-inch radius secant ogive nose.

MODEL SCALE: 0.010

DRAWING NUMBER : SS-A01167

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length, In. (Nose At X_T = 276)	1898.0	18.980
Max Width	324.0	3.240
Max Depth		
Fineness Ratio	5.858	5.858
Area - Ft^2		
Max. Cross-Sectional	572.555	0.057
Planform		
Wetted		
Base		
W.P. of tank centerline (Z_T), In.	400.0	4.00
L.E. nose radius	16.5	0.165
Origin of 2416" radius at 2231 from tank centerline	1181.0	11.810

Table III (Cont'd)

MODEL COMPONENT: VERTICAL - V_7

GENERAL DESCRIPTION: Centerline vertical tail, doublewedge airfoil with rounded leading edge.

NOTE: Same as V_5, but with manipulator housing removed.

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000139

DIMENSIONS:	FULL SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo) - Ft^2		
Planform	425.92	0.043
Span (Theo) - In.	315.72	3.157
Aspect Ratio	1.675	1.675
Rate of Taper	0.507	0.507
Taper Ratio	0.404	0.404
Sweep-Back Angles, Degrees.		
Leading Edge	45.000	45.000
Trailing Edge	26.249	26.249
0.25 Element Line	41.130	41.130
Chords:		
Root (Theo) WP	268.50	2.685
Tip (Theo) WP	108.47	1.085
MAC	199.81	1.998
Fus. Sta. of .25 MAC	1463.50	14.635
W.P. of .25 MAC	635.522	6.355
B.L. of .25 MAC	0.00	0.00
Airfoil Section		
Leading Wedge Angle - Deg.	10.00	10.00
Trailing Wedge Angle - Deg.	14.920	14.920
Leading Edge Radius	2.00	0.020
Void Area	13.17	0.0013
Blanketed Area	0.0	0.0

Table III (Con'd)

MODEL COMPONENT: WING-W_{103}

GENERAL DESCRIPTION: Configuration 3 orbiter wing.

NOTE: Same planform as W_{87}, except dihedral at trailing edge.

MODEL SCALE: 0.010

TEST NO.

DWG. NO. VL70-000139

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.) Ft^2		
Planform	2690.00	0.2690
Span (Theo In.	936.68	9.367
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	3.000	3.000
Aerodynamic Twist, degrees	3.000	3.000
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	- 10.24	-10.24
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.0.0.	689.24	6.892
Tip, (Theo) B.P.	137.85	1.379
MAC	474.81	4.748
Fus. Sta. of .25 MAC	1136.89	11.369
W.P. of .25 MAC	299.20	2.992
B.L. of .25 MAC	182.13	1.821
EXPOSED DATA		
Area (Theo) Ft^2	1752.29	0.175
Span, (Theo) In. BP108	720.68	7.207
Aspect Ratio	2.058	2.058
Taper Ratio	0.245	0.245
Chords		
Root BP108	562.40	5.624
Tip 1.00 $\frac{b}{2}$	137.85	1.379
MAC	393.03	3.930
Fus. Sta. of .25 MAC	1185.31	11.853
W.P. of .25 MAC	300.20	3.002
B.L. of .25 MAC	251.76	2.518
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root $\frac{b}{2}$ =	0.10	0.10
Tip $\frac{b}{2}$ =	0.12	0.12
Data for (1) of (2) Sides		
Leading Edge Cuff Planform Area Ft^2	120.33	0.012
Leading Edge Intersects Fus M. L. @ Sta	560.0	5.600
Leading Edge Intersects Wing @ Sta	1035.0	10.350

Table IV.

HEAT TRANSFER GAGE LOCATIONS

ORBITER (L_{oms} = 12.903)

FUSELAGE

GAGE NO.	X_m/L_{oms}	X_{oms} (FROM NOSE)	ACTUAL x_{oms}	DESIRED Y_{oms}	ACTUAL Y_{oms}	ϕ
1	0	0	0	0	+.012	0
2	0.005	065	086		012	
3	0 02	.258	249		012	
4	0 04	516	539		020	
5	0 06	.774	797		017	
6	0.08	1 032	1 051		019	
7	0 10	1,290	1.324		019	
8	0.12	1,548	1,570		019	
9	0 14	1,806	1 831		018	
10	0.16	2 065	2.078		.016	
11	0.20	2 580	2 578		009	
12	0.25	3,226	3 221		008	
13	.30	3 871	3 873		005	
14	0.35	4,516	4 520		006	
15	0.40	5.161	5 172		006	
16	0.45	5 806	5 795		005	
17	0 50	6 452	6 452		005	
18	0.60	7 742	7 698		003	
19	0 70	9,032	9 033		006	
20	0.80	10 322	10 320		004	
21	0 90	11 613	11 616		.011	
22	1.00	12 903	12 907		010	0
23	0 03	387	391		.016	180°
24	0 06	774	780		.014	
25	0.09	1.161	1 171		004	
26	0.125	1 613	1 623		.006	
27	0 15	1 935	1,940		006	
28	0 130	2 323	2 333		.007	
29	0 160	2 065	2 067		009	
30	0 170	2 194	2 200		009	
31	0.50	6 452	6.461		003	
32	0 70	9 032	9 023	0	.001	180°
33	0 10	1 290	1.284	—	.569	30°
34	0 20	2 580	2,593	—	.638	30°
35	0 30	3 871	3.875	500	490	—
36	0.40	5 161	5.151	500	494	—
37	0 60	7,742	7 749	.500	.494	—
38	0 80	10 322	10.323	500	.497	—

VERTICAL TAIL

GAGE NO.	DESIRED Z_{oms}	ACTUAL z_{oms}
39	6 096	6 091
40	6 961	6 970
41	7 867	7 861
42	8 157	8 156

WING LOWER SURFACE

GAGE NO.	DESIRED X_{oms} (FROM NOSE)	ACTUAL x_{oms}	DESIRED Y_{oms}	ACTUAL Y_{oms}
43	5.161	5.165	1 171	1 159
44	6 451	6.442		1.156
45	7,742	7 750		1.161
46	9 032	9 040		1.166
47	11 613	11 615	1.171	1.163
48	- 7 742	7 780	1 873	1 930
49	9.032	9.029		1,867
50	10 322	10 322		1,871
51	12 037	12 035	1 873	1 867
52	8 399	8 407	2 342	2 337
53	9 032	9 044		2,332
54	10 322	10 326		2 338
55	11 211	11 219	2 342	2.341
56	9 500	9 499	2 810	2,804
57	10,322	10 322		2,804
58	10 940	10 941	2,810	2,811
59	12 020	12 018	2 810	2,804
60	9,554	9 563	3 513	3 455
61	10,322	10 321	3 513	3 510
62	11 424	11 479	3,513	3 507
63	10,172	10 145	3 981	3 972
64	11 060	11 066	3 981	3 967
65	8 520	8,503	1,373	1 854
66	10 658	10 666	4 449	4,436
67	11 293	11 293	4 449	4 448
68	11 345	11 347	TIP	TIP

WING LEADING EDGE

GAGE NO.	LOCATION		
	DESIRED	ACTUAL	χ ACTUAL
69-70	Y_o = 1.171	Y_o = 1.155	
71-72	X = 5 160	X = 5.164	
73 74	X = 6 503	X = 6 508	
75 76	X = 7,742	X = 7.753	
77-78	Y_o = 2.342	Y = 2.351	8.332
79-86*	Y_o = 2.810	Y = 2.823	8.801
89-90	Y_o = 3.513	Y = 3.517	9.487
91 98*	Y_o = 3 981	Y = 4 033	10.016
101-102	Y_o = 4.449	Y = 4.466	10.577

*GAGE NU MBERS 87, 88 & 99, 100 WERE NOT FABRICATED BECAUSE OF SPACE LIMITATIONS.

Table IV. (Conl'd)

TANK (L_{tms} = 18.650)

GAGE NO.	X_{ms}/L_{tms}	X_{ms} (FROM NOSE)	ACTUAL x	ϕ
103	0.00	0	0	—
104	.005	.080	.076	220
105	01	186	.196	199
106	04	.746	.760	180
107	08	1 492	1 498	
108	.15	2.798	2 802	
109	.20	3.730	3 744	
110	21	3 917	3 932	180
111	.04	746	740	0
112	25	4 663	4 686	180
113	35	6 528	6 545	
114	375	6.994	7 009	
115	40	7.460	7 478	
116	425	7.926	7.953	
117	.45	8 393	8 414	
118	.475	8 859	8 877	
119	50	9.325	9.341	180
120	343	6 397	6 407	225
121	55	10 258	10 271	180
122	475	7 572	7.590	193
123	.60	11 190	11 215	180
124	.65	12 123	12.145	
125	70	13 055	13 083	
126	80	14.920	14 940	
127	.90	16 785	16 818	
128	937	17 475	17 458	180
129	.406	7.572	7.594	167
130	.15	2 798	2 800	0
131	44	8 206	8.223	199
132	08	1.492	1.492	0
133	475	8 859	8 871	199
134	50	9 325	9 335	199.
135	90	16 785	16.796	199
136	40	7.460	7 464	221.5
137	.50	9 326	9 344	
138	60	11.190	11.205	
139	.70	13 055	13 073	
140	80	14 920	14 940	
141	.85	15 853	15 882	
142	.90	16 785	16.818	221 5
143	825	15 386	15 386	214.
144	85	15.853	15 874	
145	875	16 319	16 339	
146	90	16 785	16.805	
147	.925	17.251	17.280	
148	960	17.904	17 902	241.
149	.85	15 853	15 874	247.5
150	.90	16.785	16.795	247 5
151	20	3 730	3.729	270.
152	40	7.460	7.465	
153	.50	9 325	9 322	
154	.60	11 190	11 200	
155	70	13 055	13 066	
156	80	14 920	14 930	
157	90	16 785	16 810	270.
158	60	11 190	11 196	315
159	80	14 920	14 930	315.
160	40	7 460	7.459	0
161	.60	11 190	11 191	0
162	.80	14 920	14.914	0

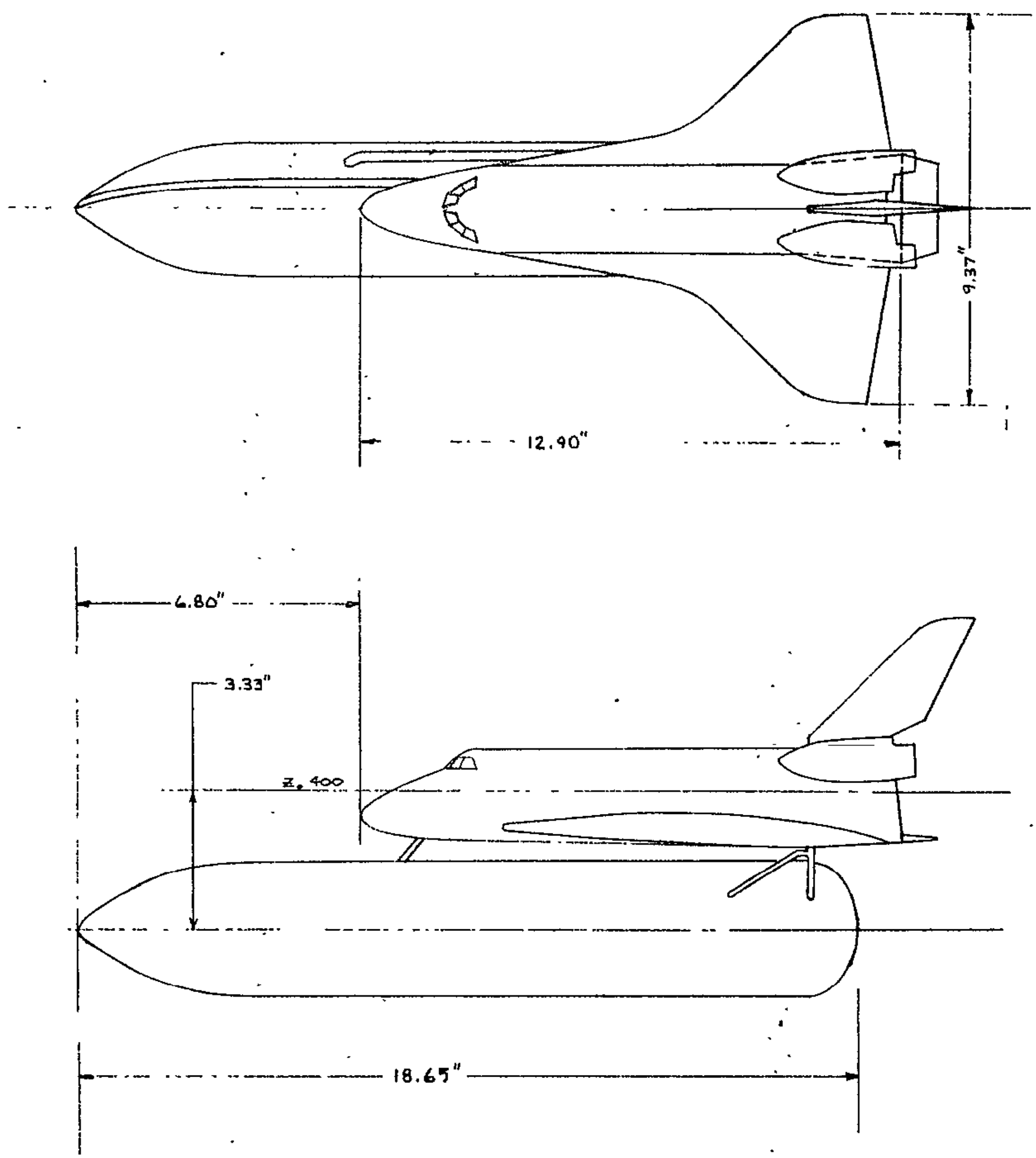
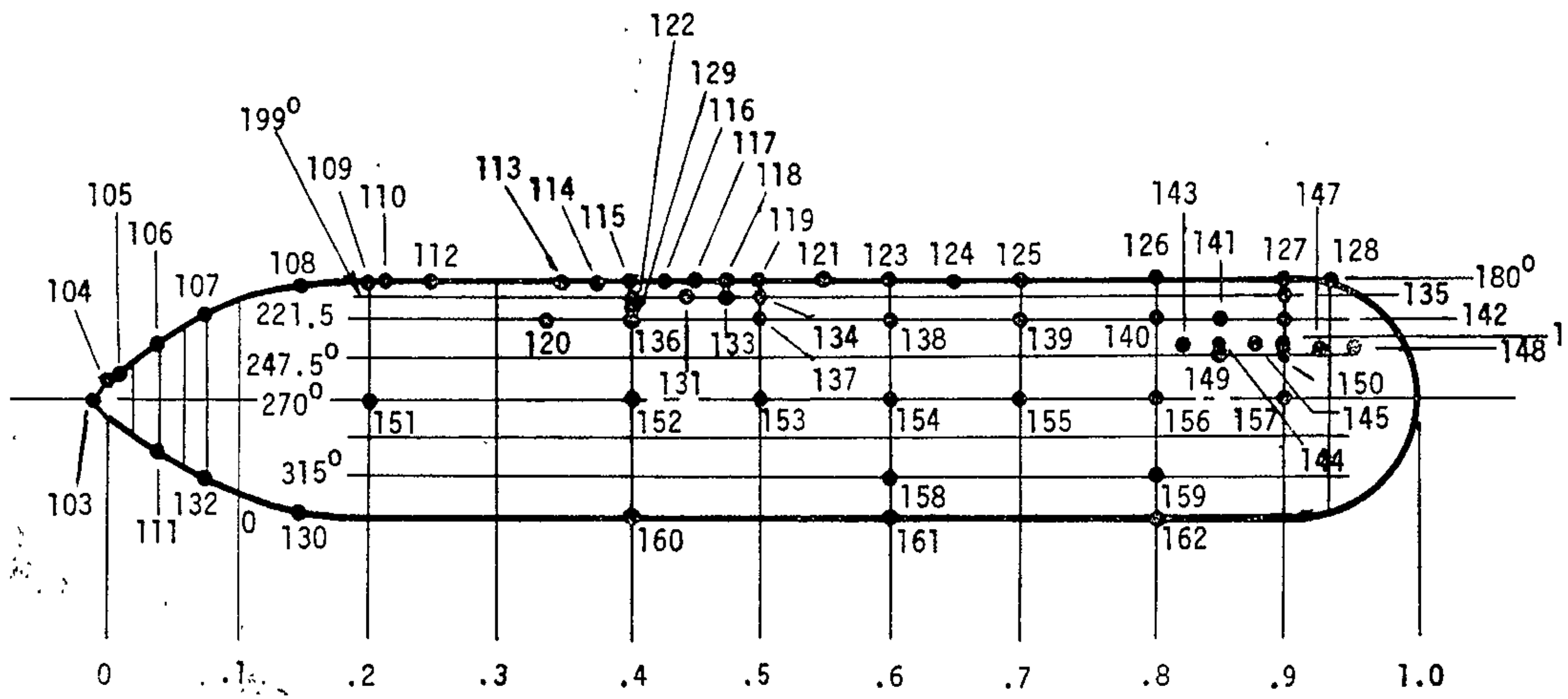
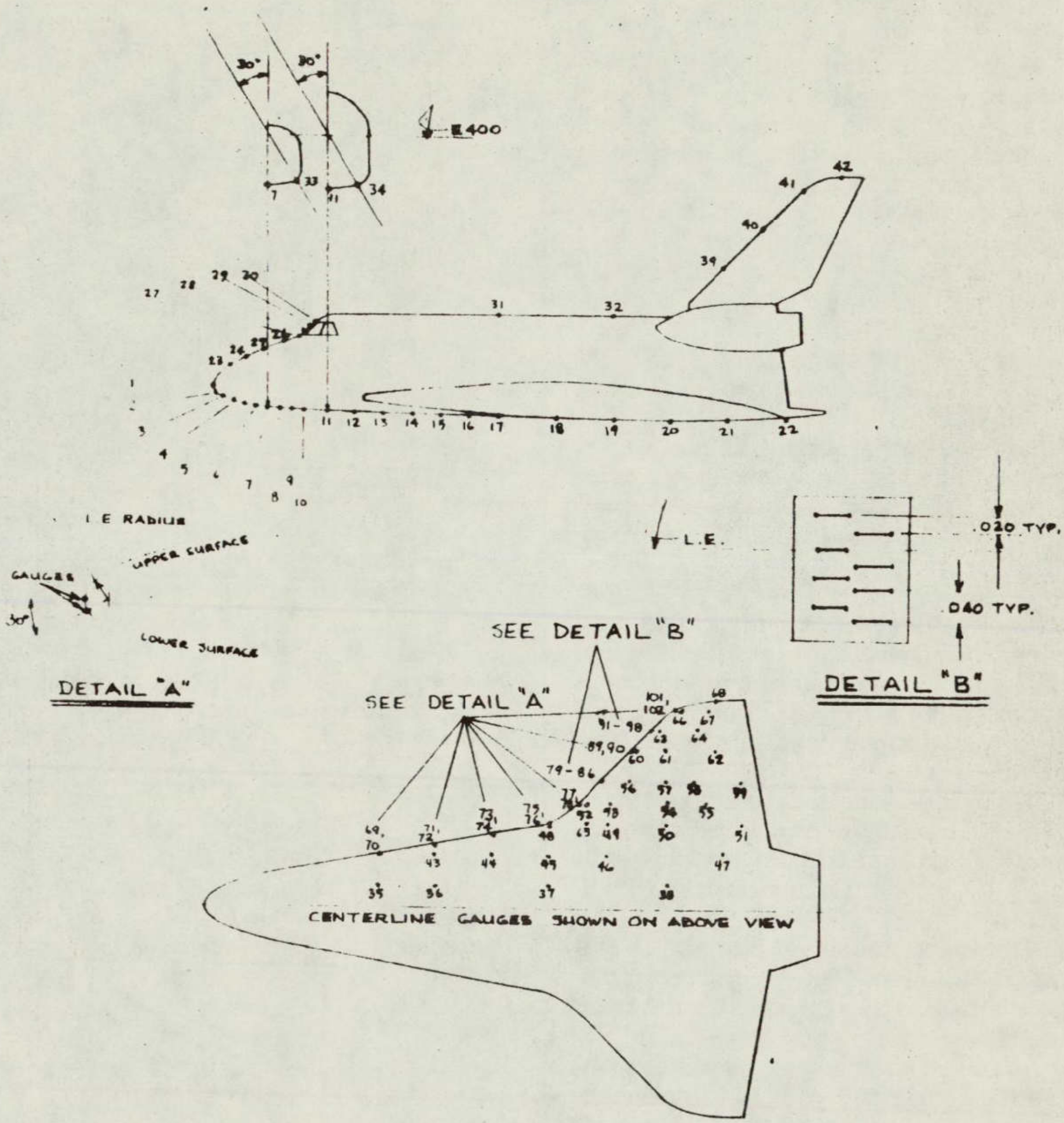


Figure 1. Configuration 3 Orbiter/ET



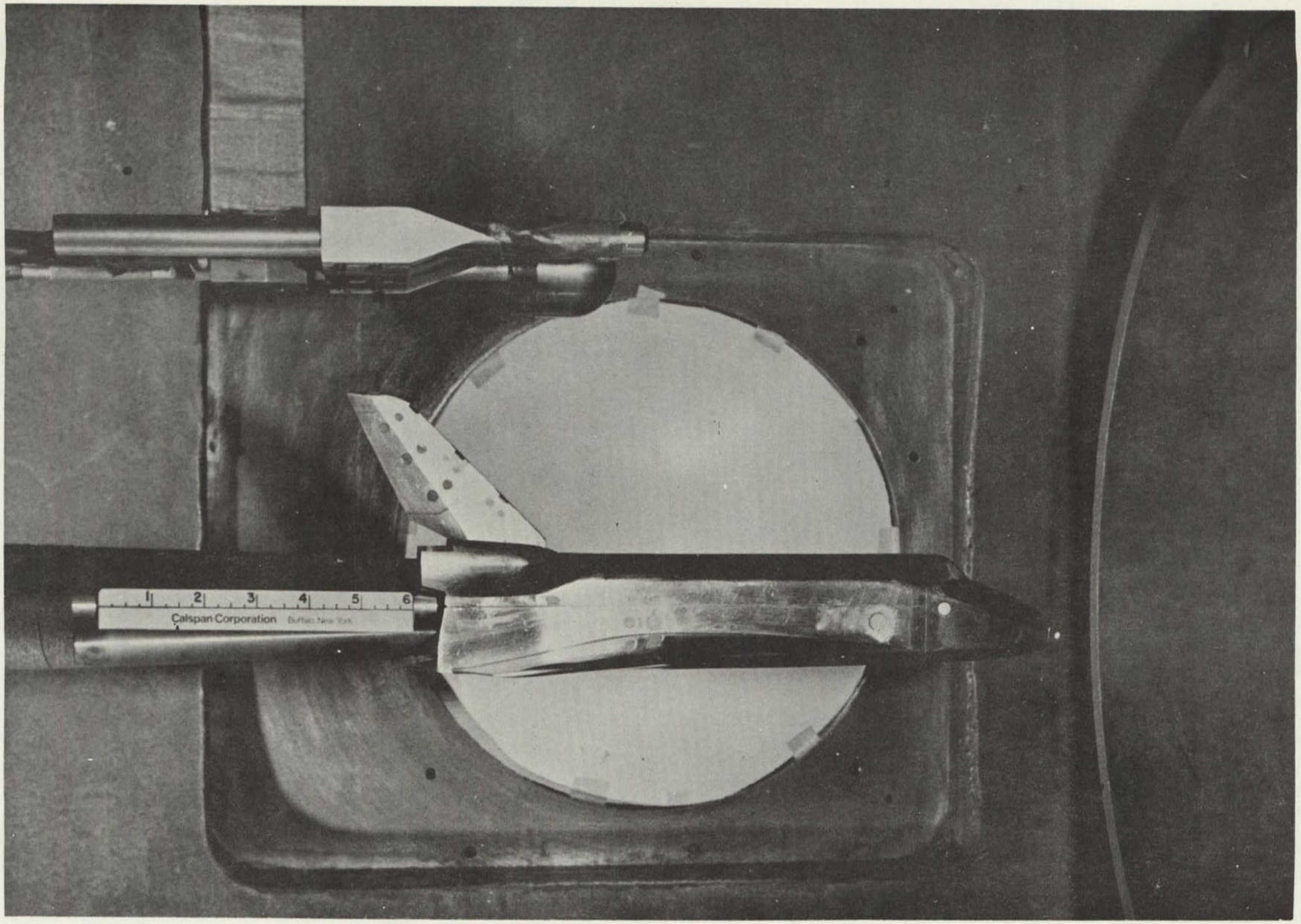
a. Model 37-T Instrumentation Locations

Figure 2. - Model instrumentation.



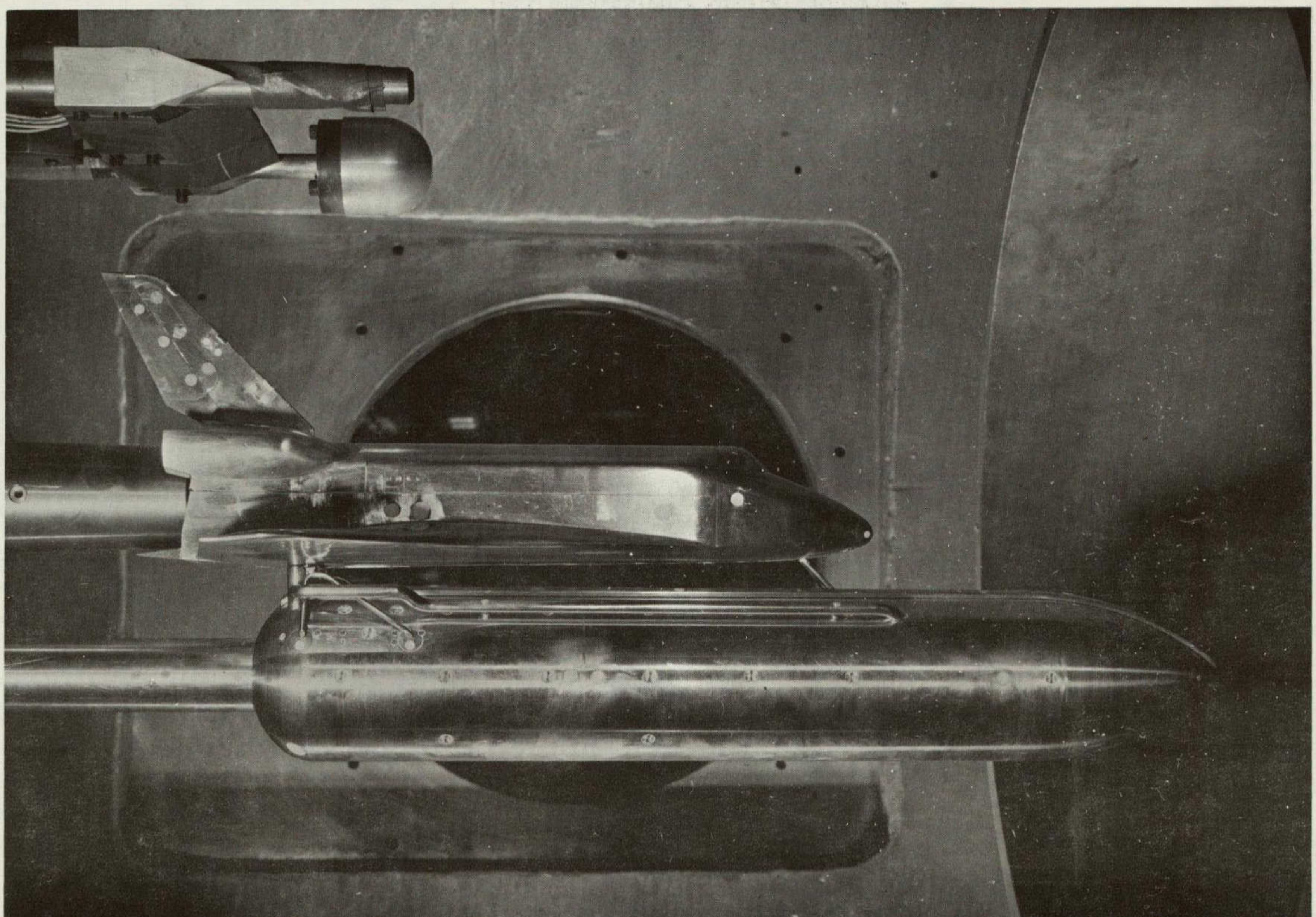
b. 37-0 Instrumentation Locations

Figure 2. - Concluded.



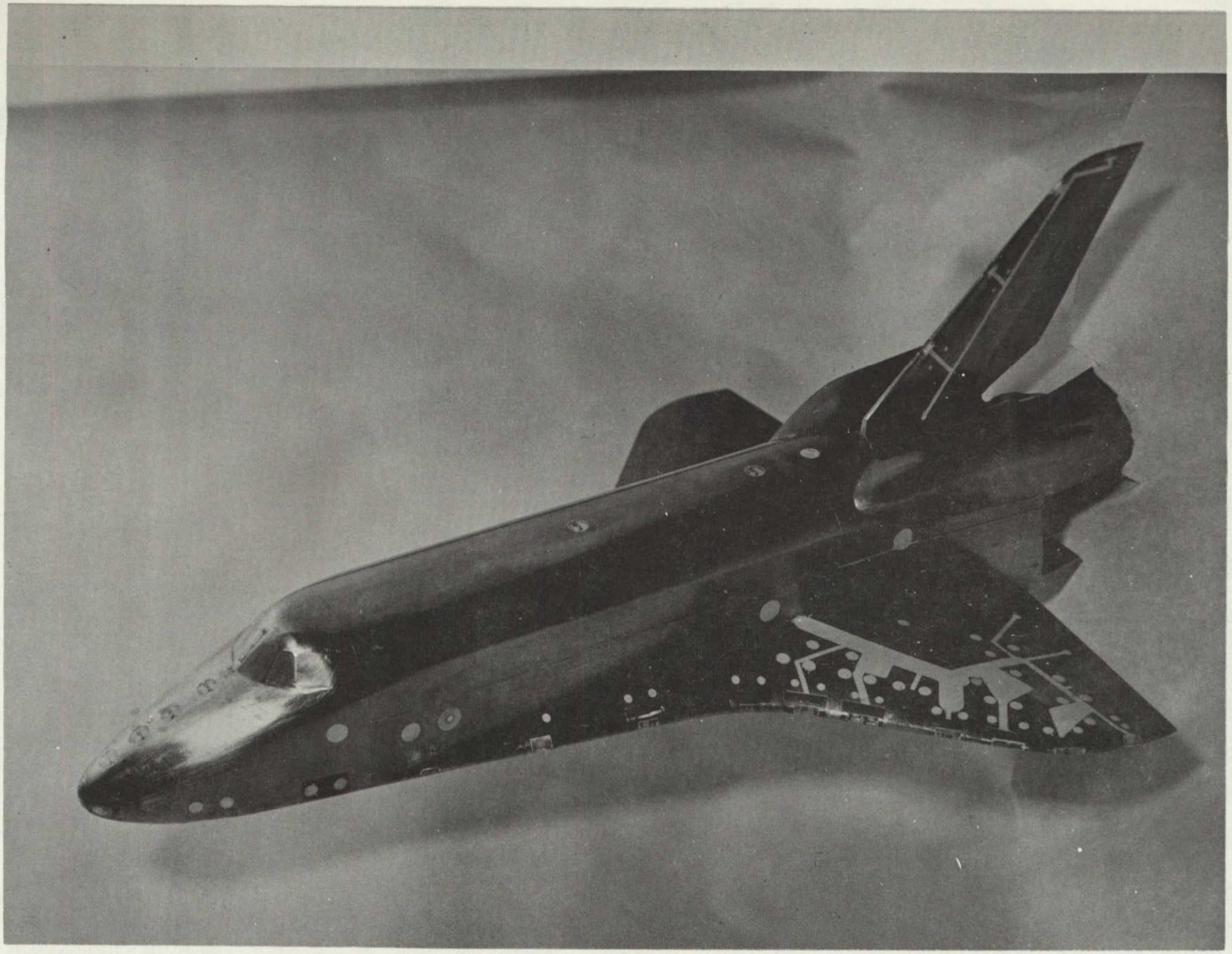
a. Installation of model 37-0 - Orbiter Alone

Figure 3.- Model photographs.



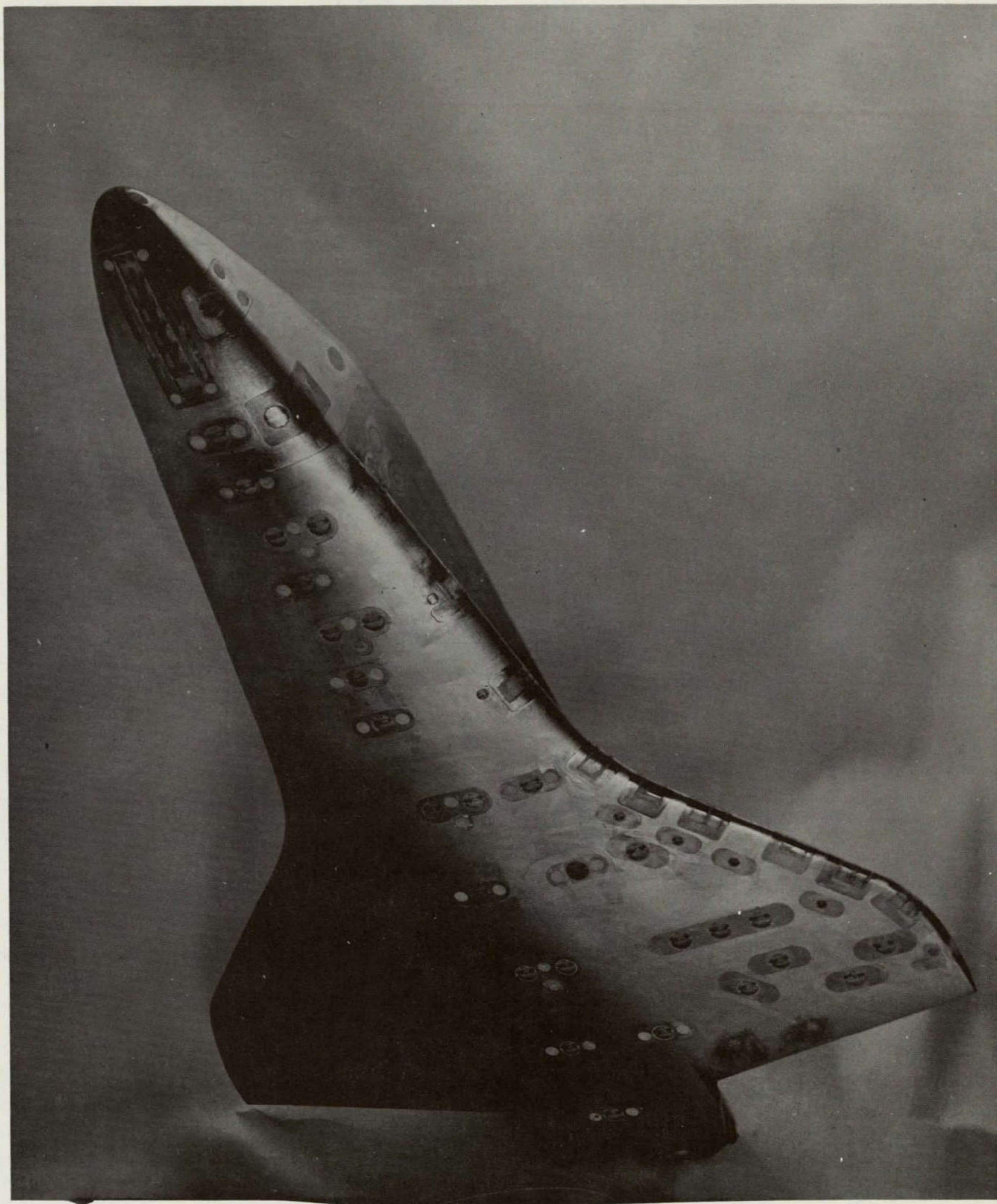
b. Installation of Model 37-OT - Orbiter/Tank

Figure 3. - Continued.



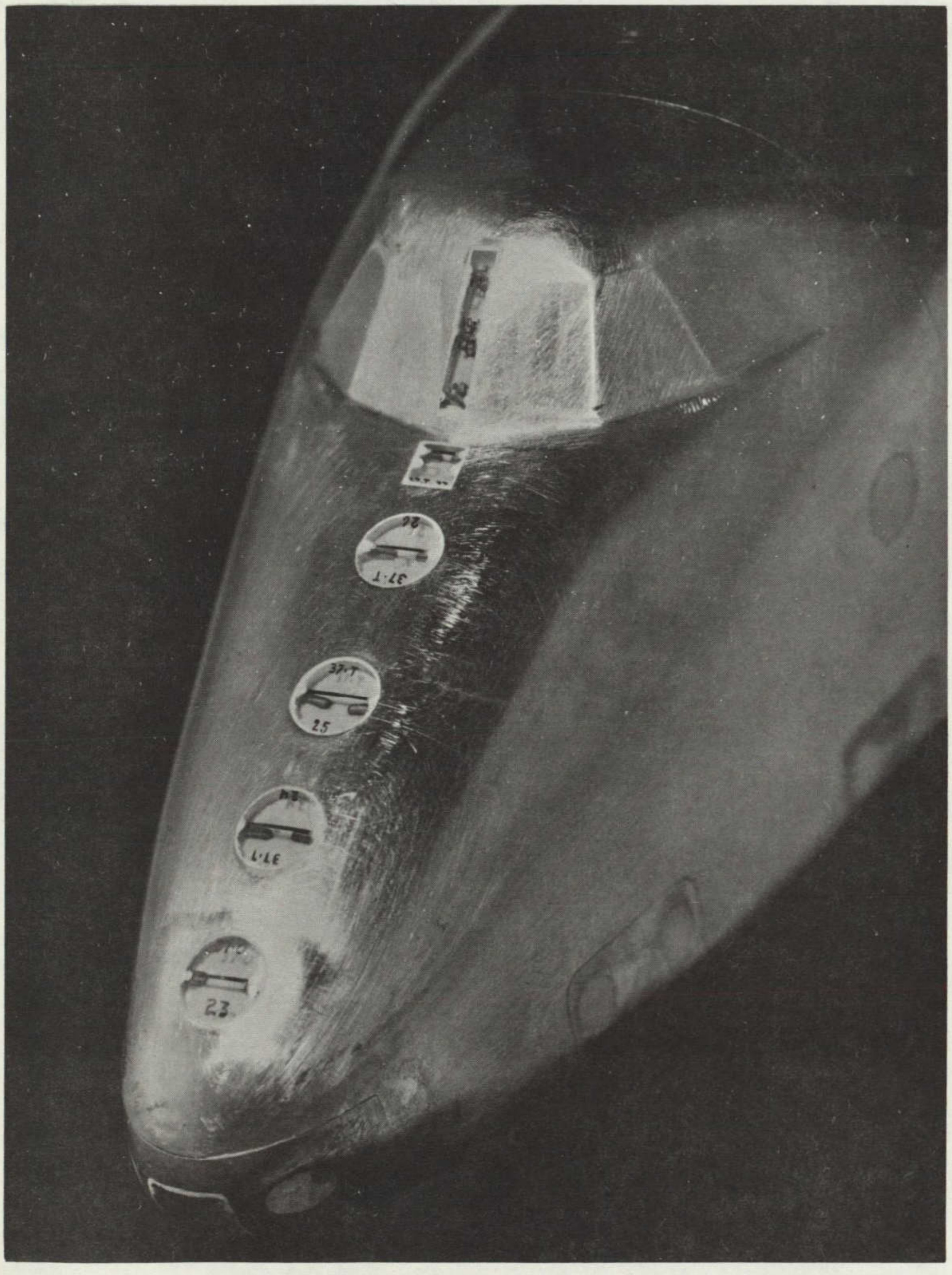
c. Instrumentation - Orbiter Top View

Figure 3. - Continued.



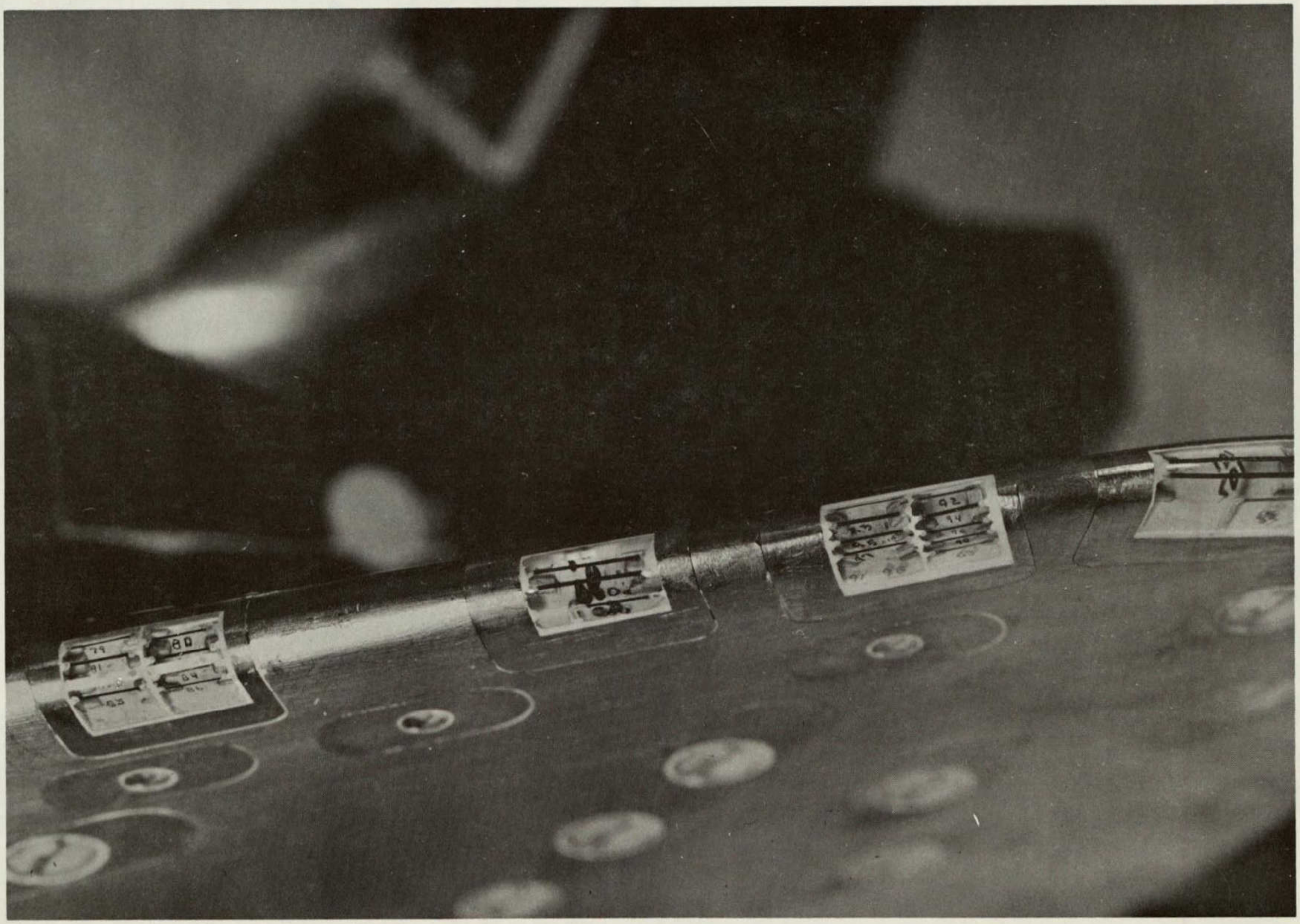
d. Instrumentation - Orbiter Bottom Surface

Figure 3. - Continued.



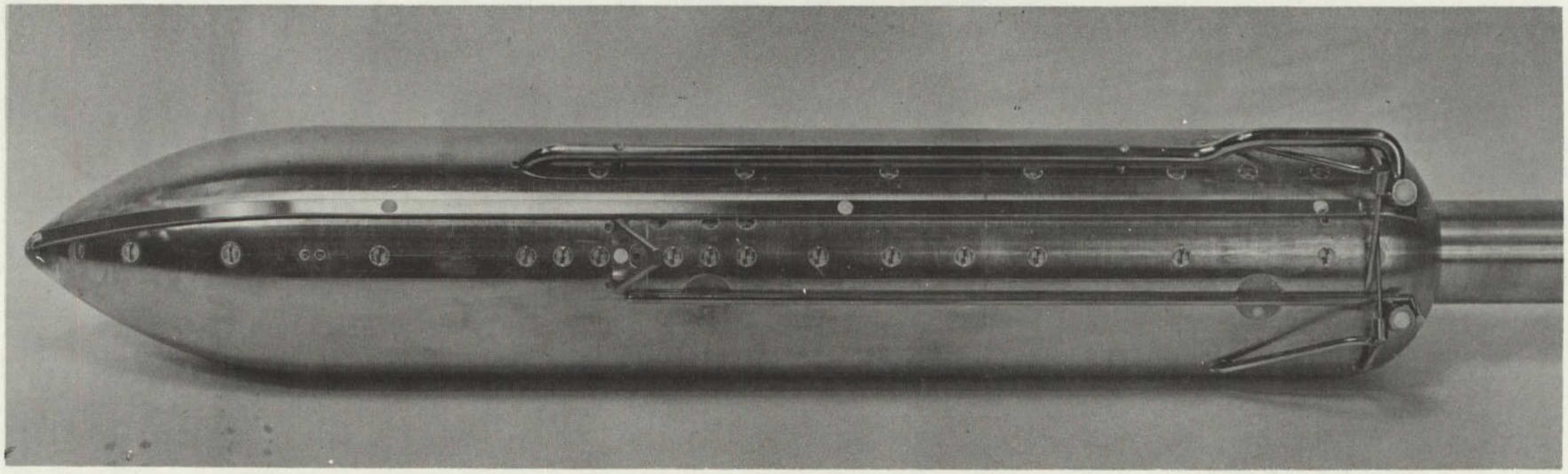
e. Instrumentation - Orbiter Nose and Canopy

Figure 3. - Continued.



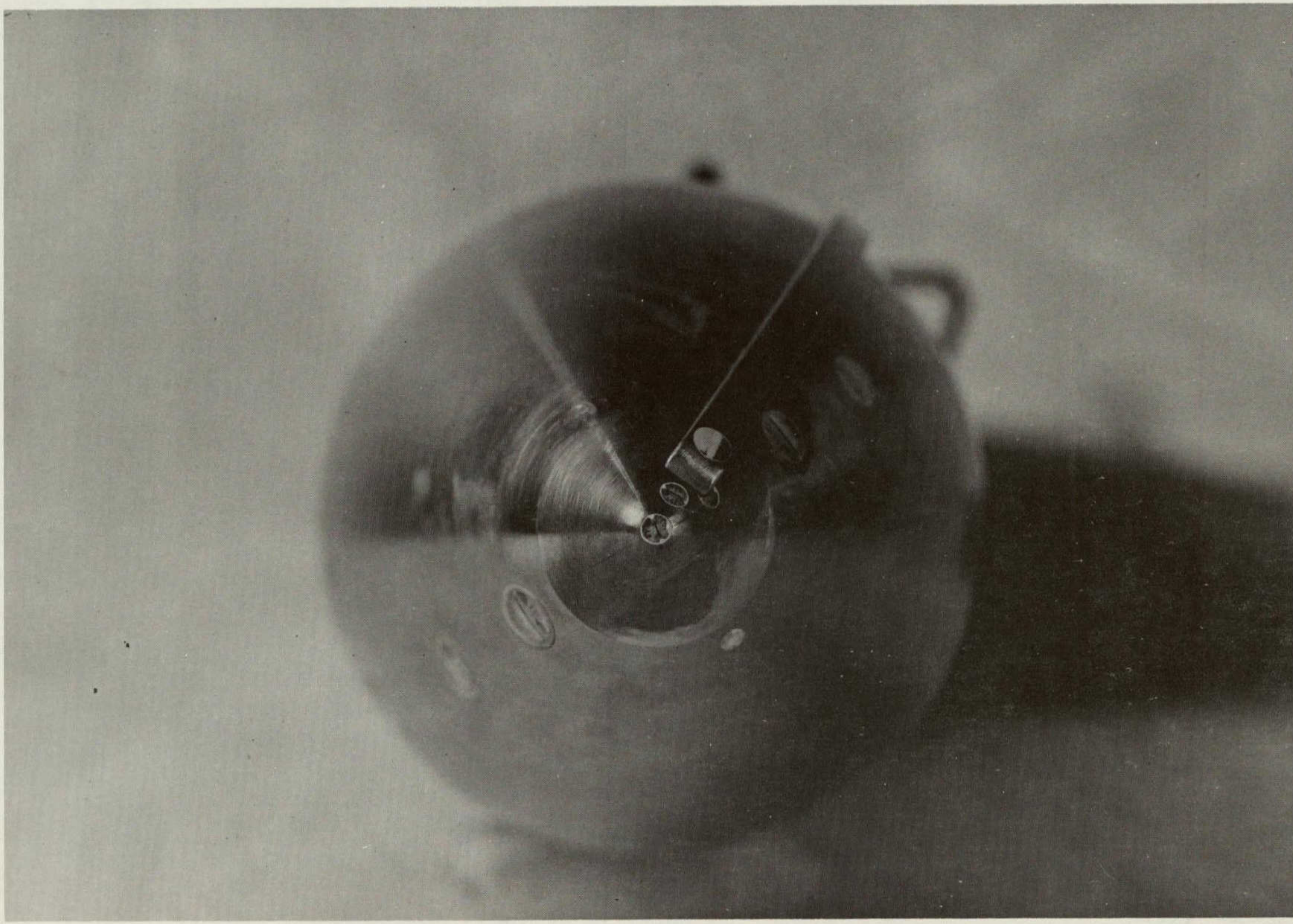
f. Instrumentation - Orbiter Wing Leading Edge

Figure 3. - Continued.



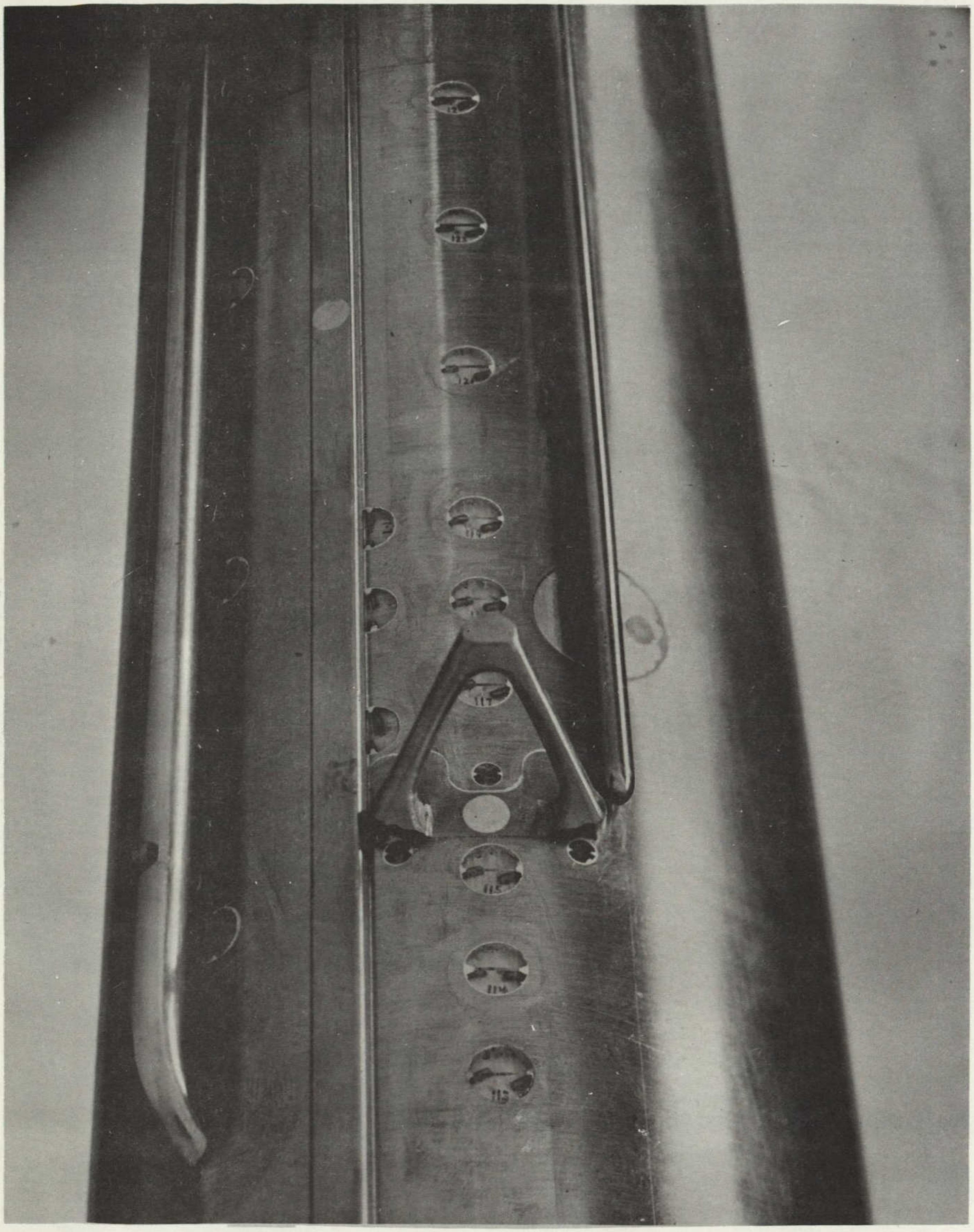
g. Instrumentation - Tank Top View

Figure 3. - Continued.

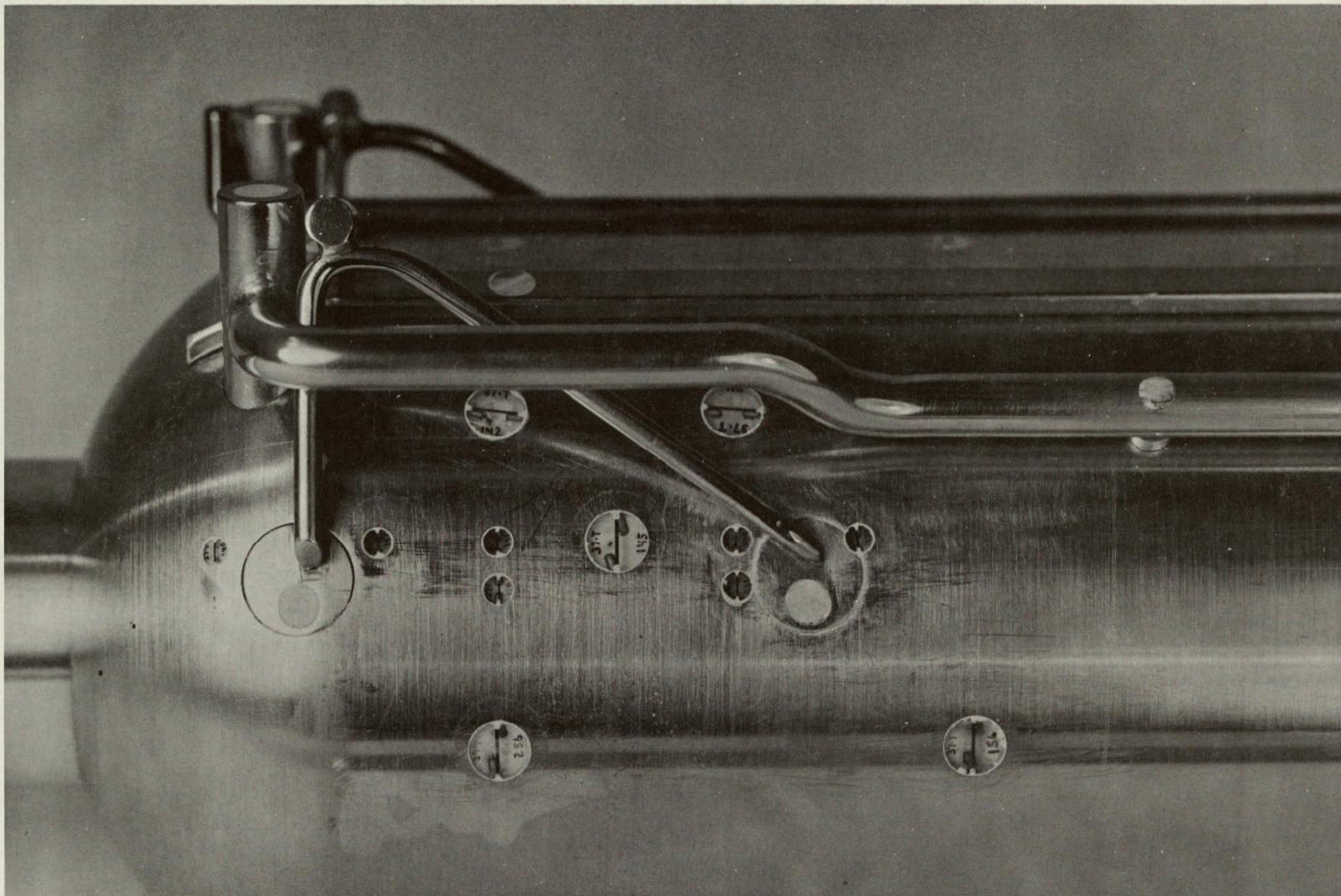


h. Instrumentation - Tank Nose

Figure 3. - Continued.

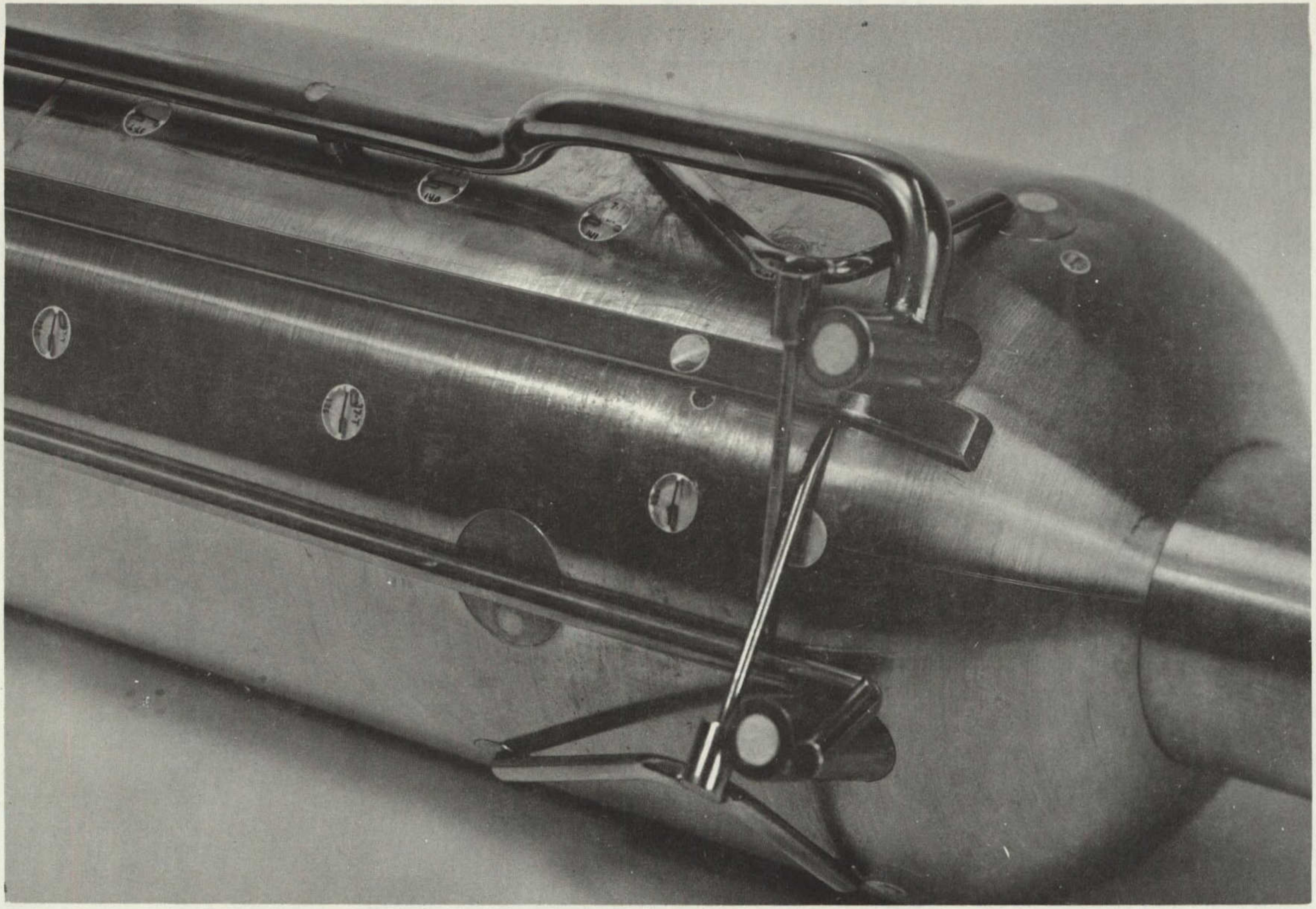


i. Instrumentation - Tank Forward Attachment Strut
Figure 3. - Continued.



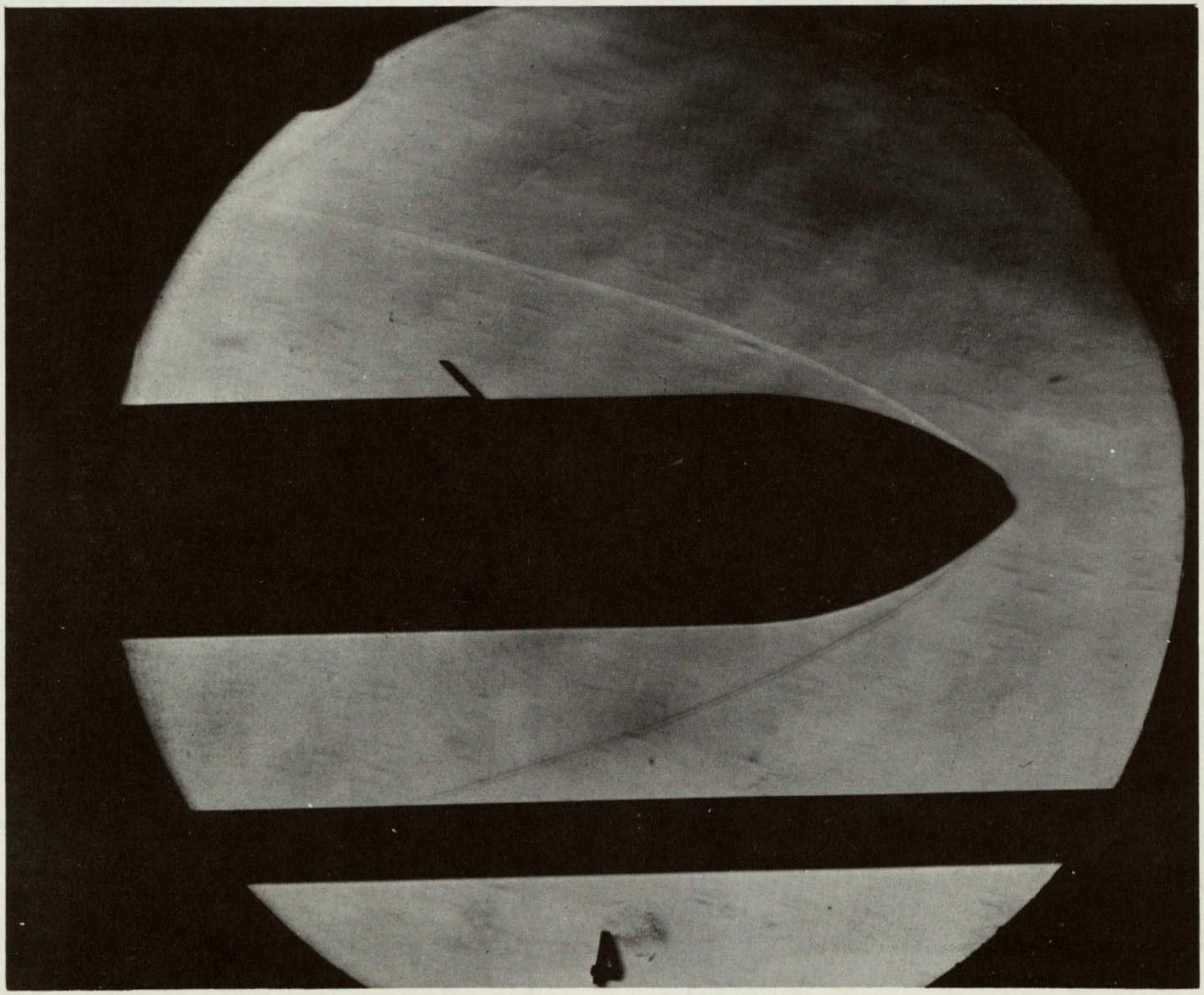
j. Instrumentation - Tank Aft Attachment Struts - Side View

Figure 3. - Continued.



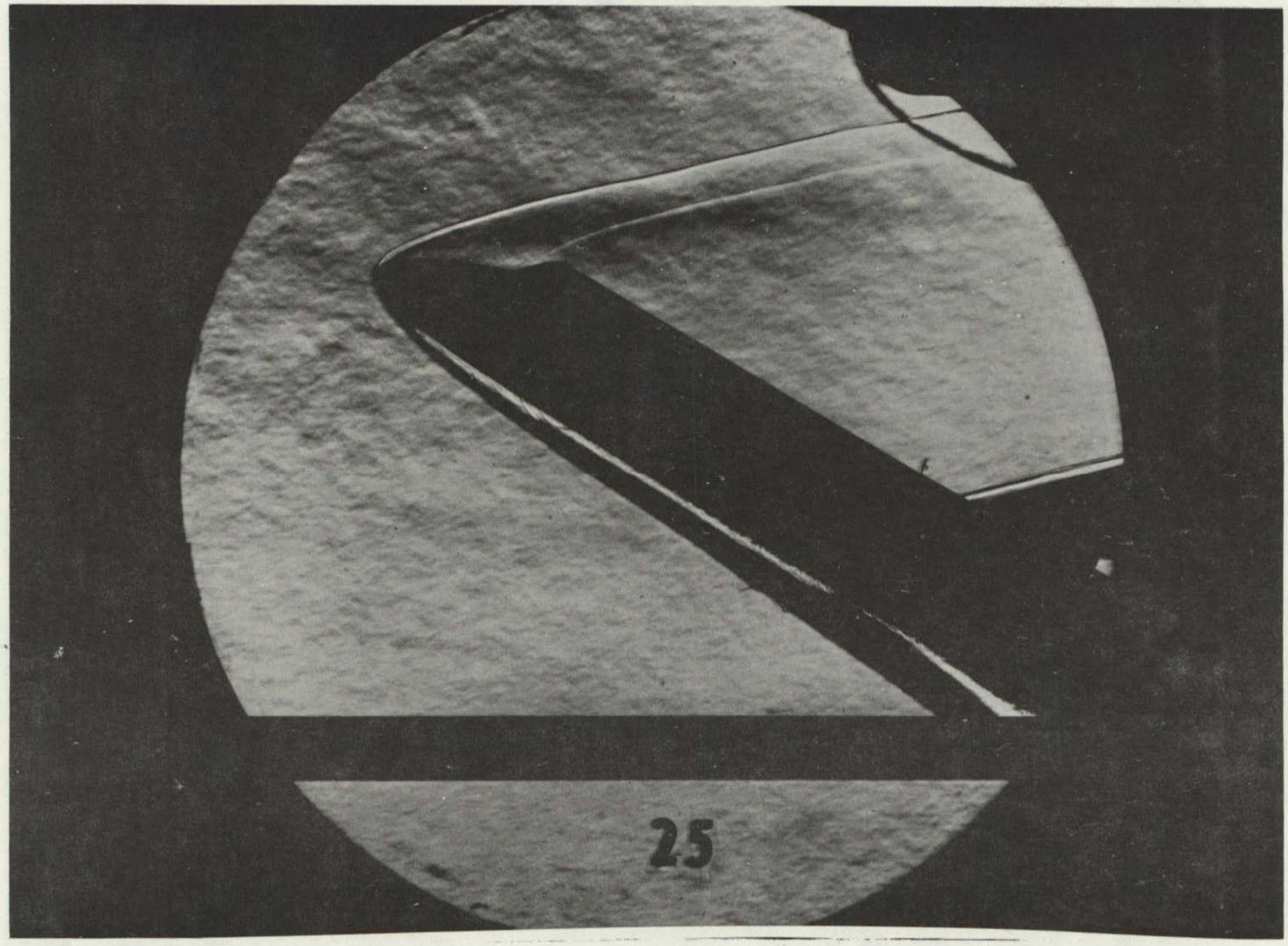
k. Instrumentation - Tank Aft Attachment Struts - Top View

Figure 3. - Continued.



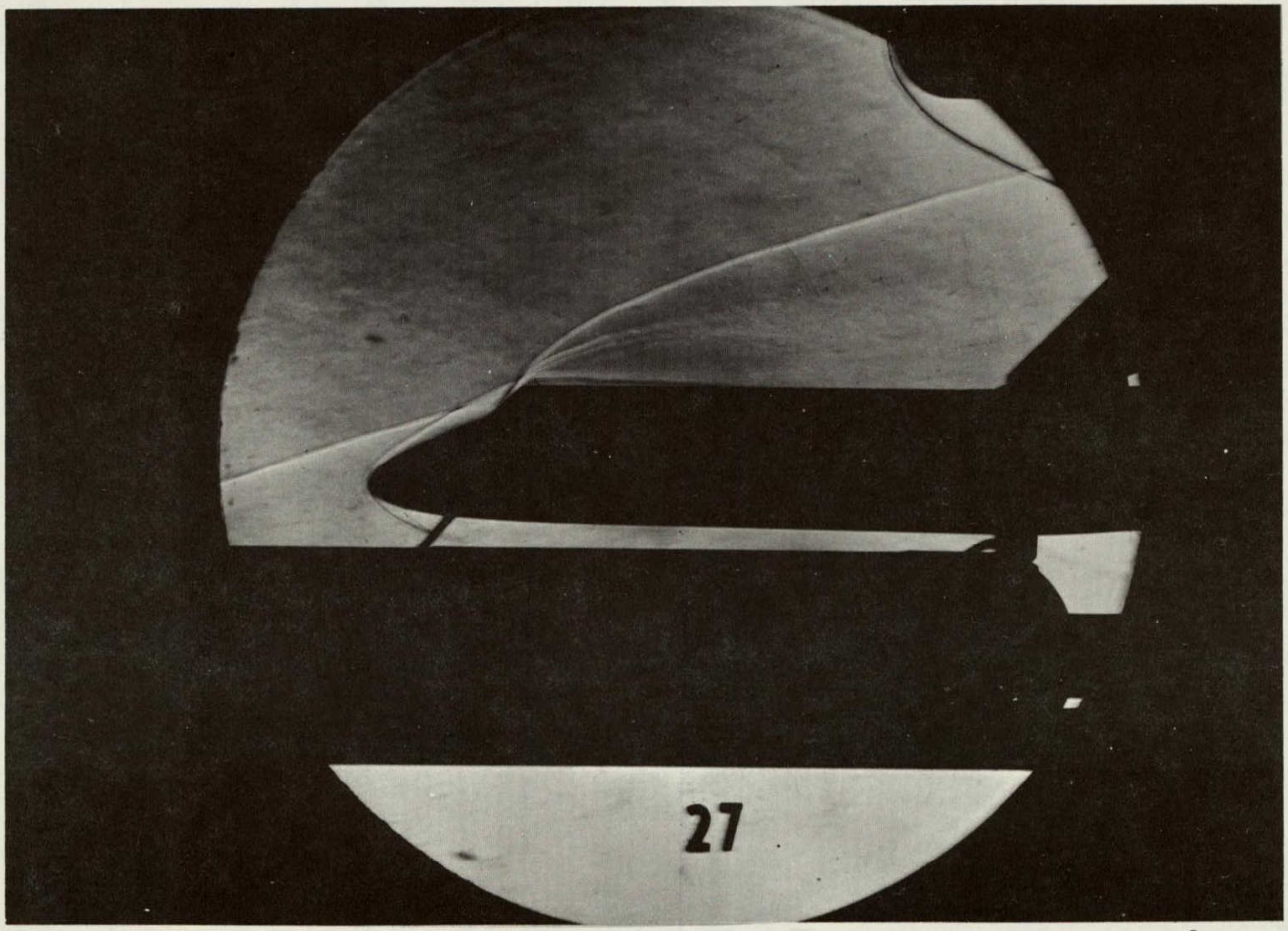
1. Sample Schlieren, Tank Alone, Run 4, $\alpha = 0°$, $M_\infty = 6.99$, $R_e/ft = 0.12 \times 10^6$

Figure 3. - Continued.



m. Sample Schlieren, Orbiter Alone, Run 25, α = 30°, M_∞ = 7.92, R_e/ft = 7.55 x 10^6

Figure 3. - Continued.



n. Sample Schlieren, Orbiter/Tank, Run 27, $\alpha = 0°$, $M_\infty = 7.61$, $R_e/ft = 1.20 \times 10^6$

Figure 3. - Concluded.

DATA FIGURES

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OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)

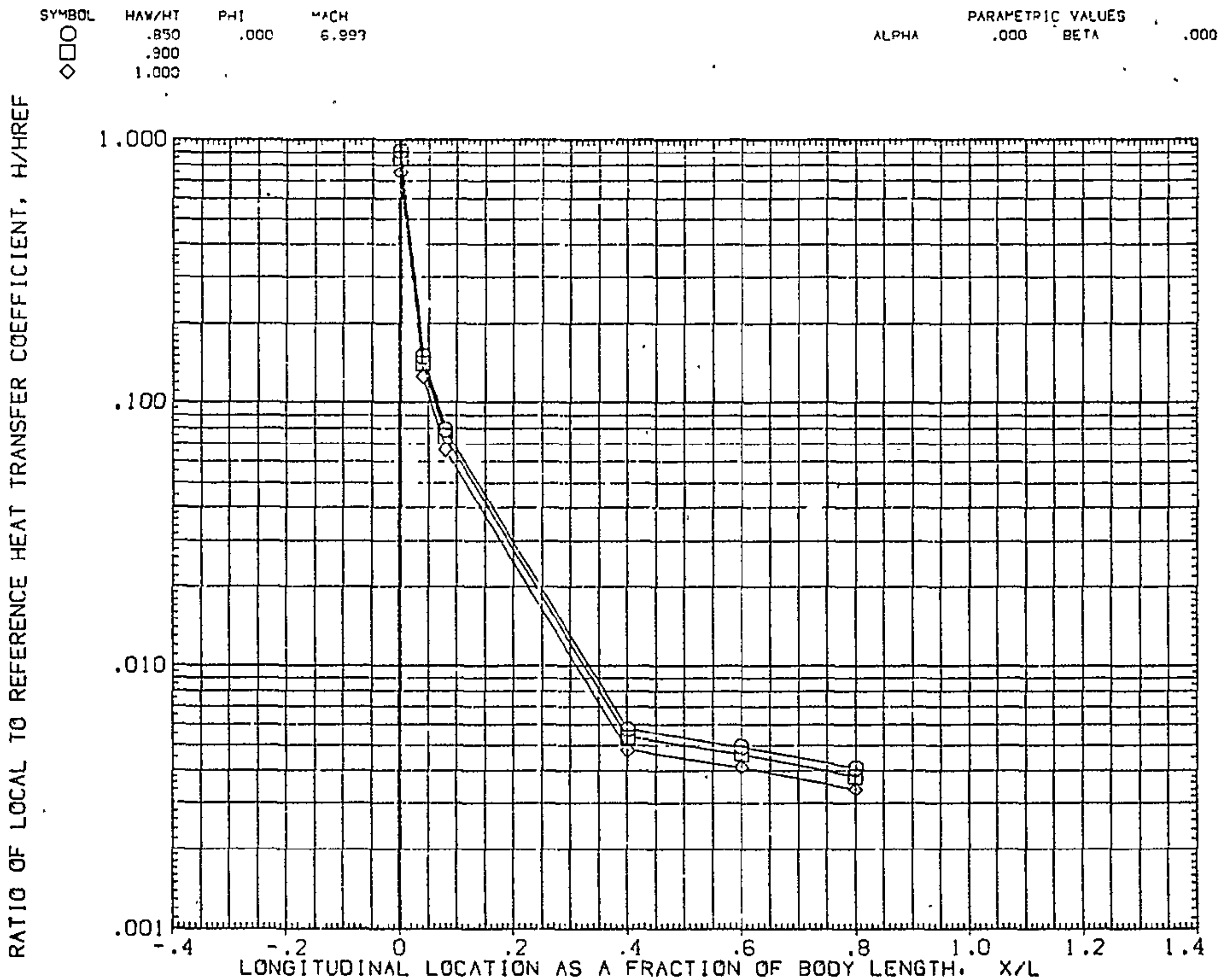


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

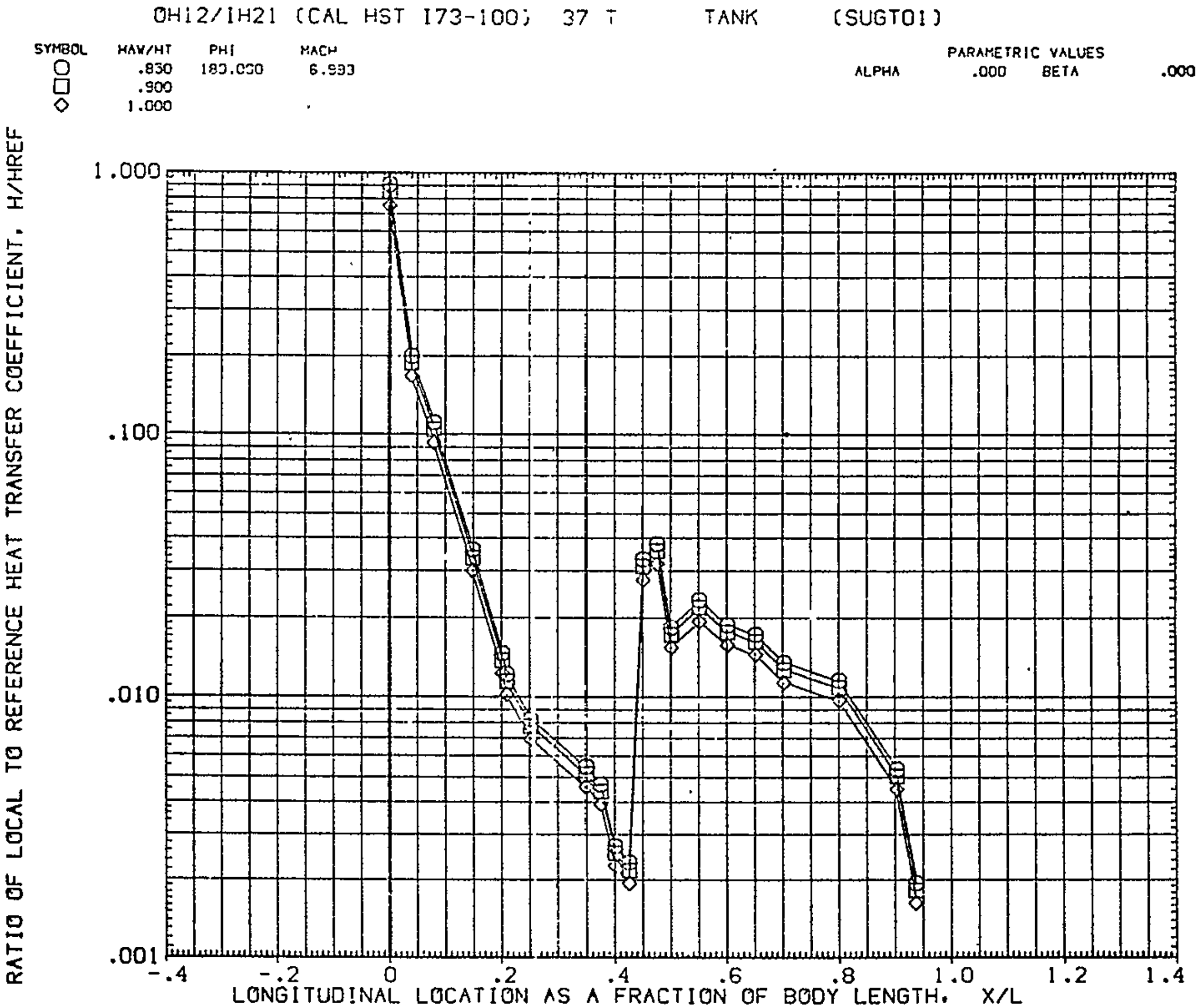


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

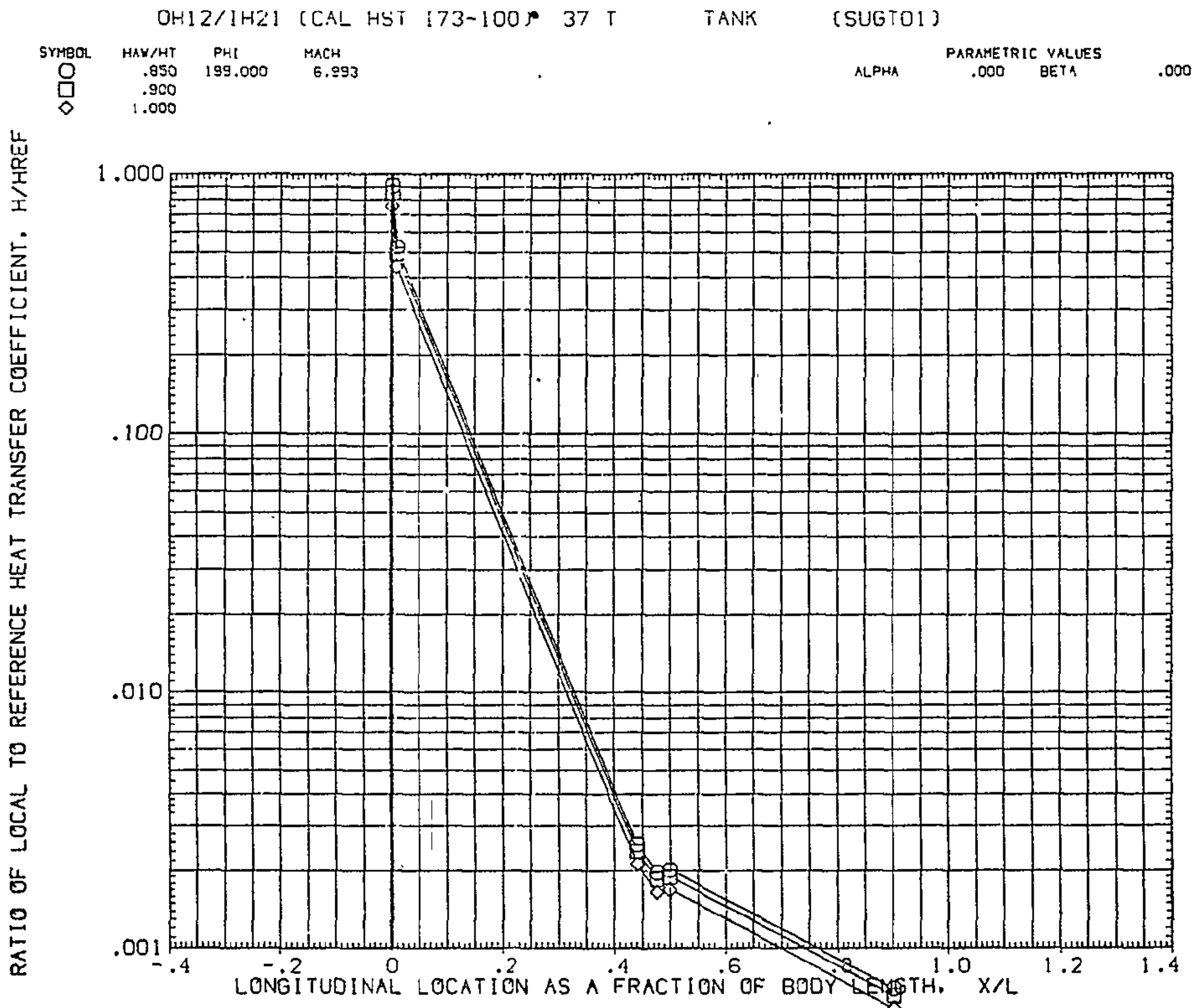


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

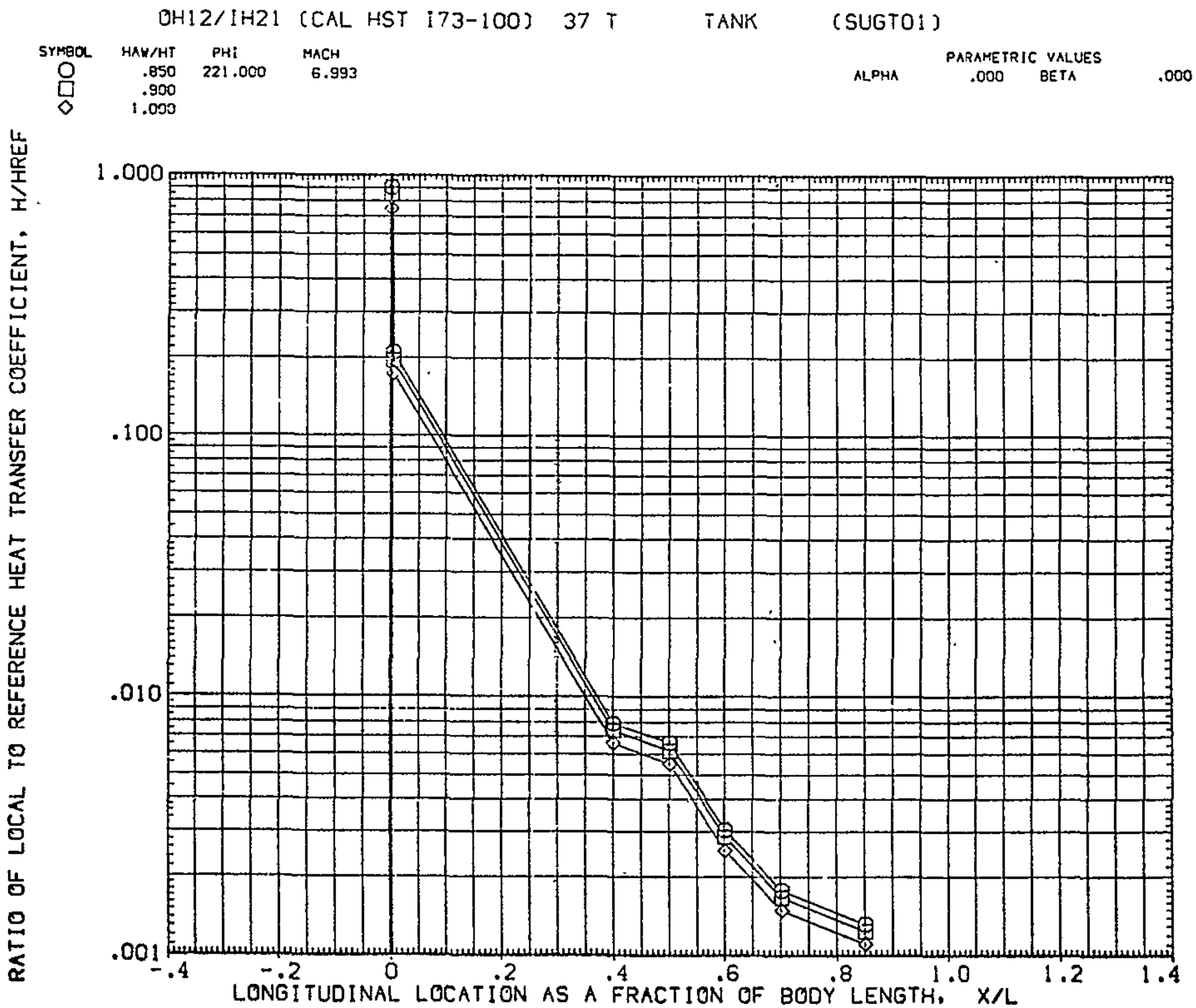


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 T TANK (SUGT01)

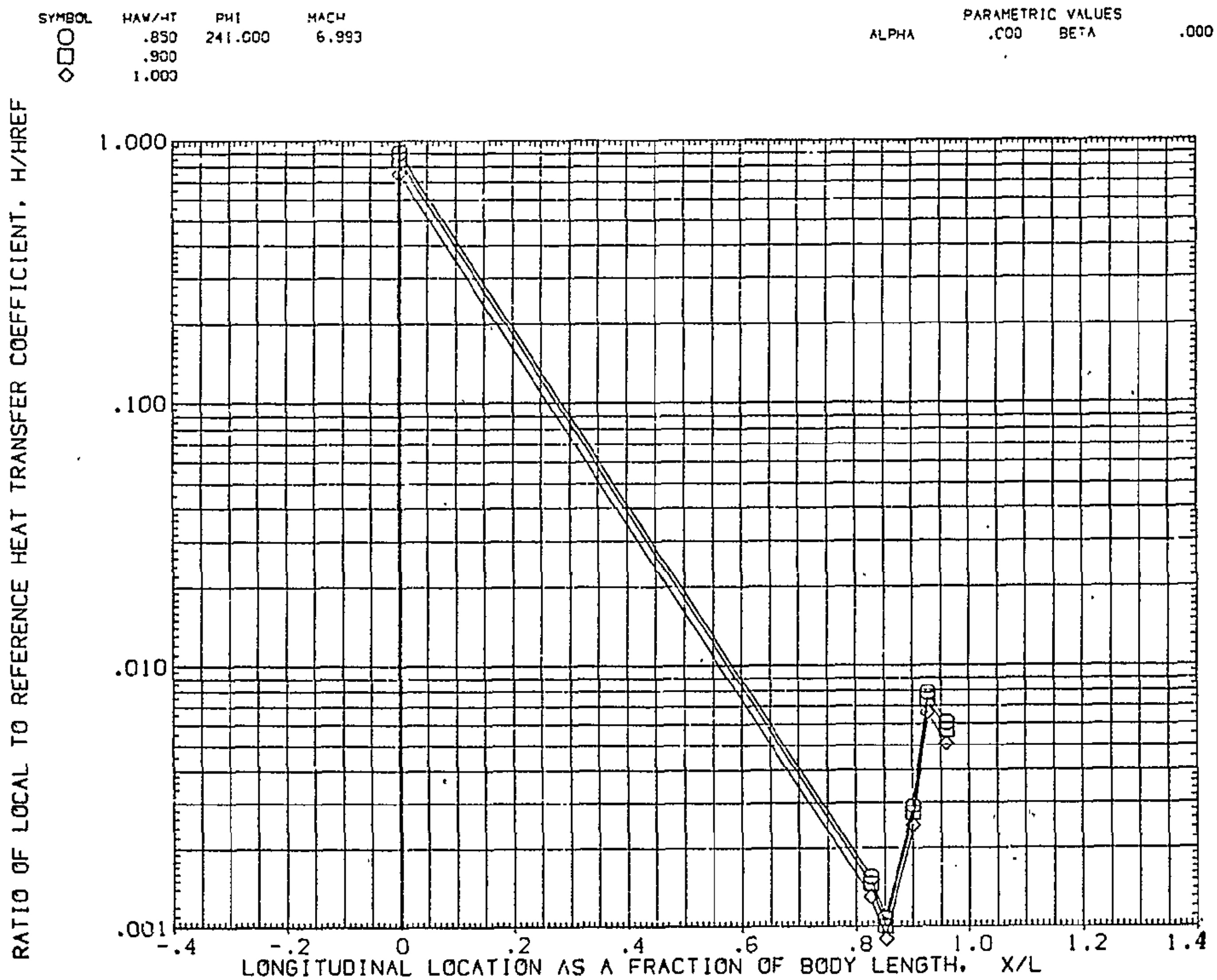
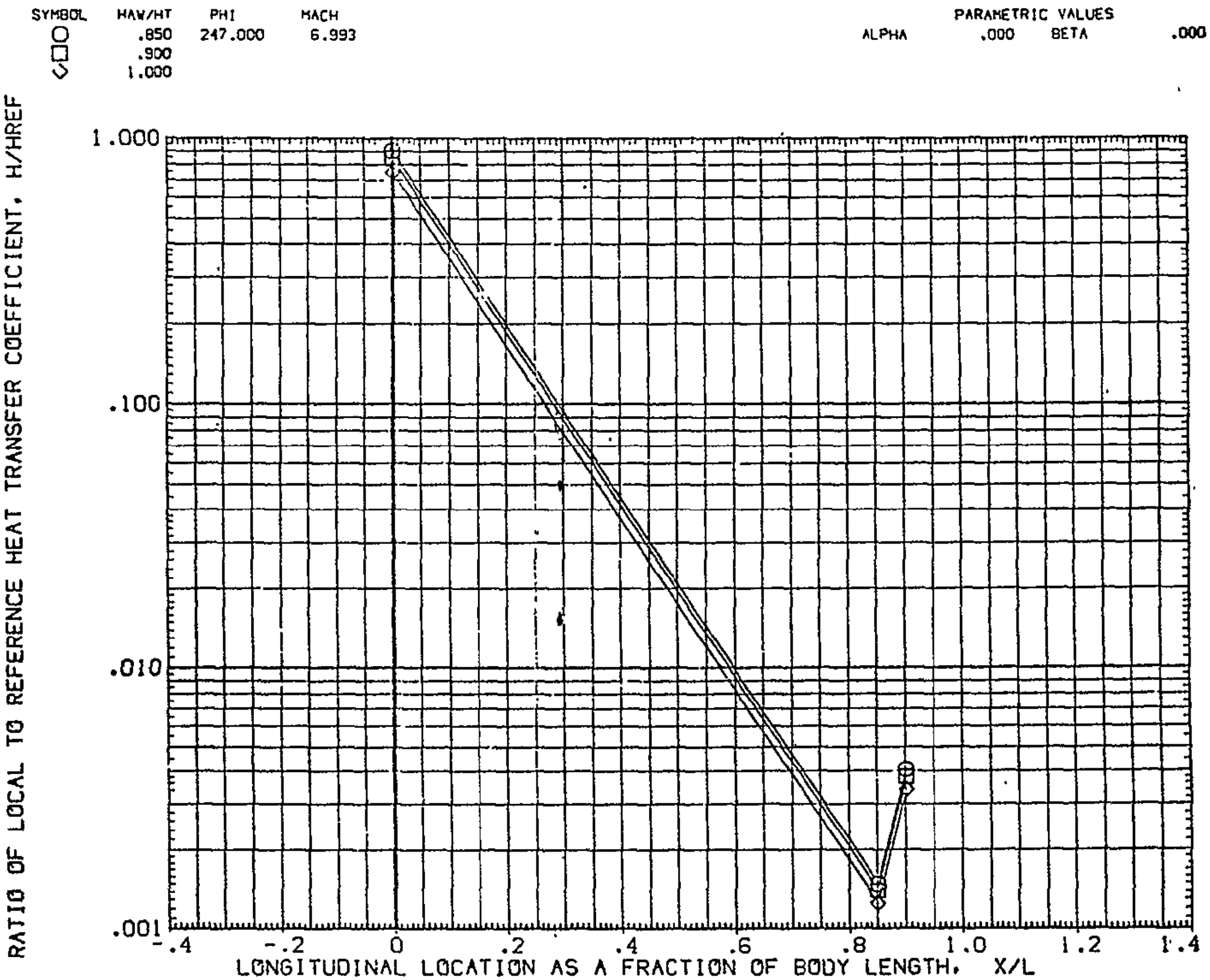


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 T TANK (SUGT01)



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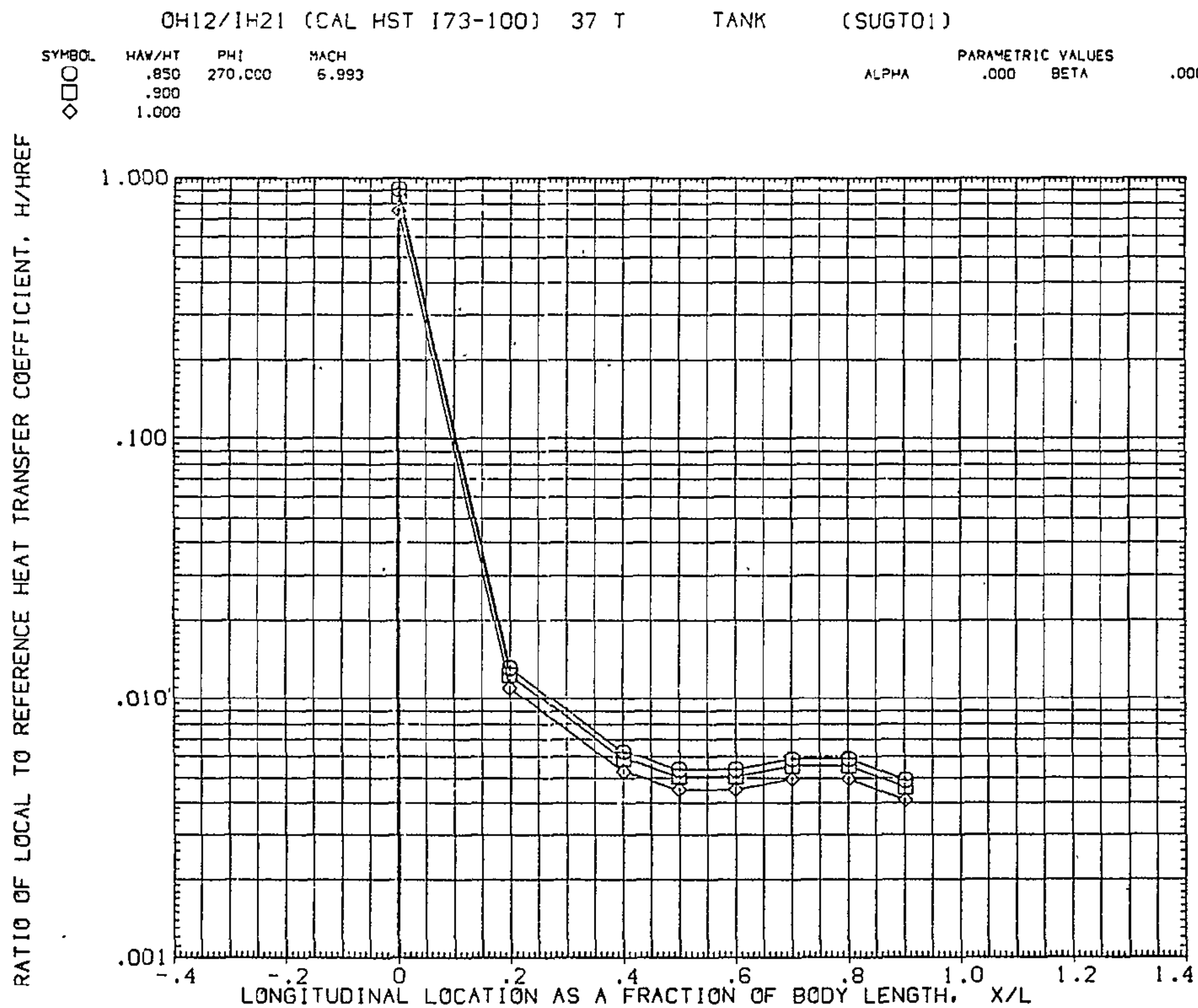
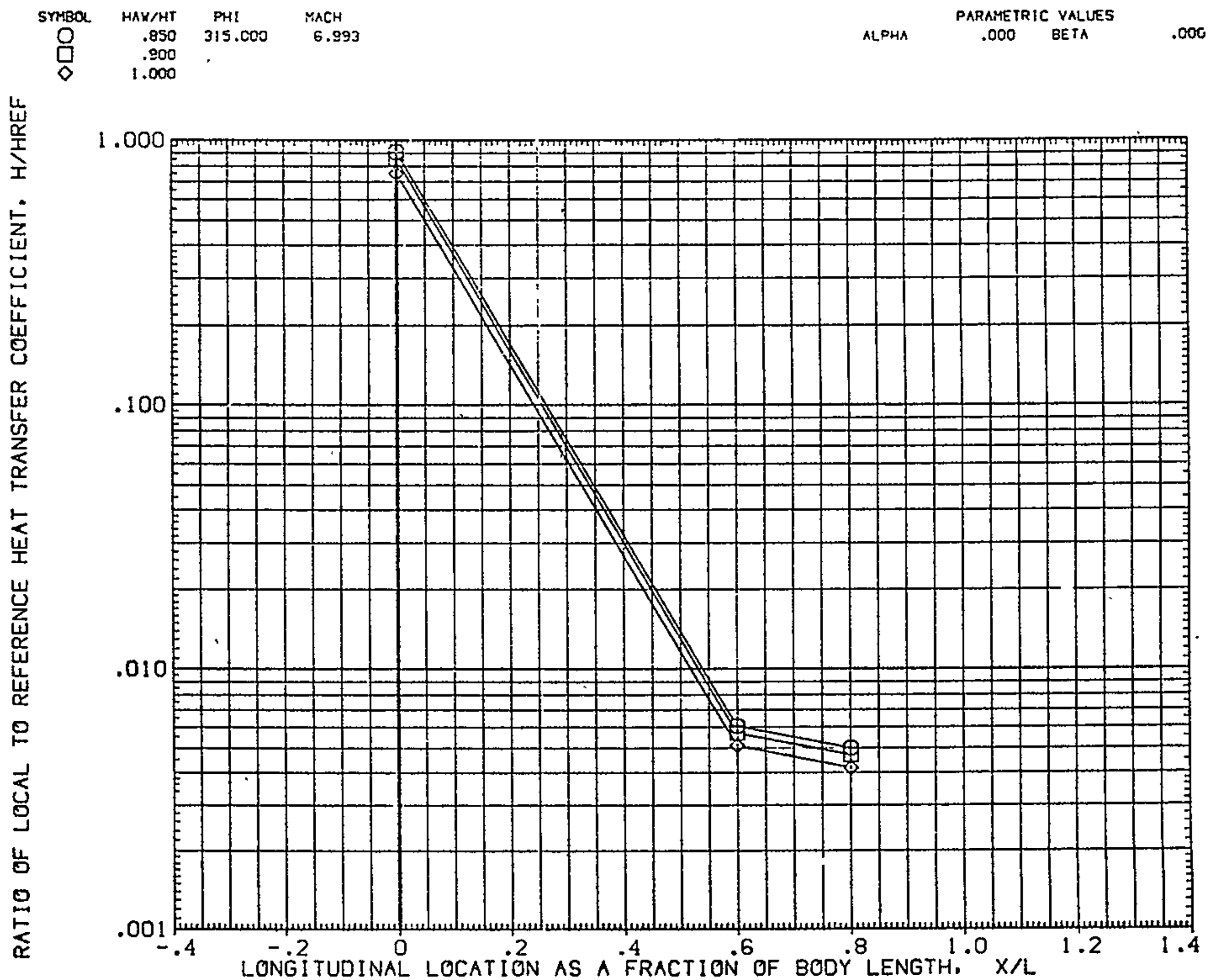


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)



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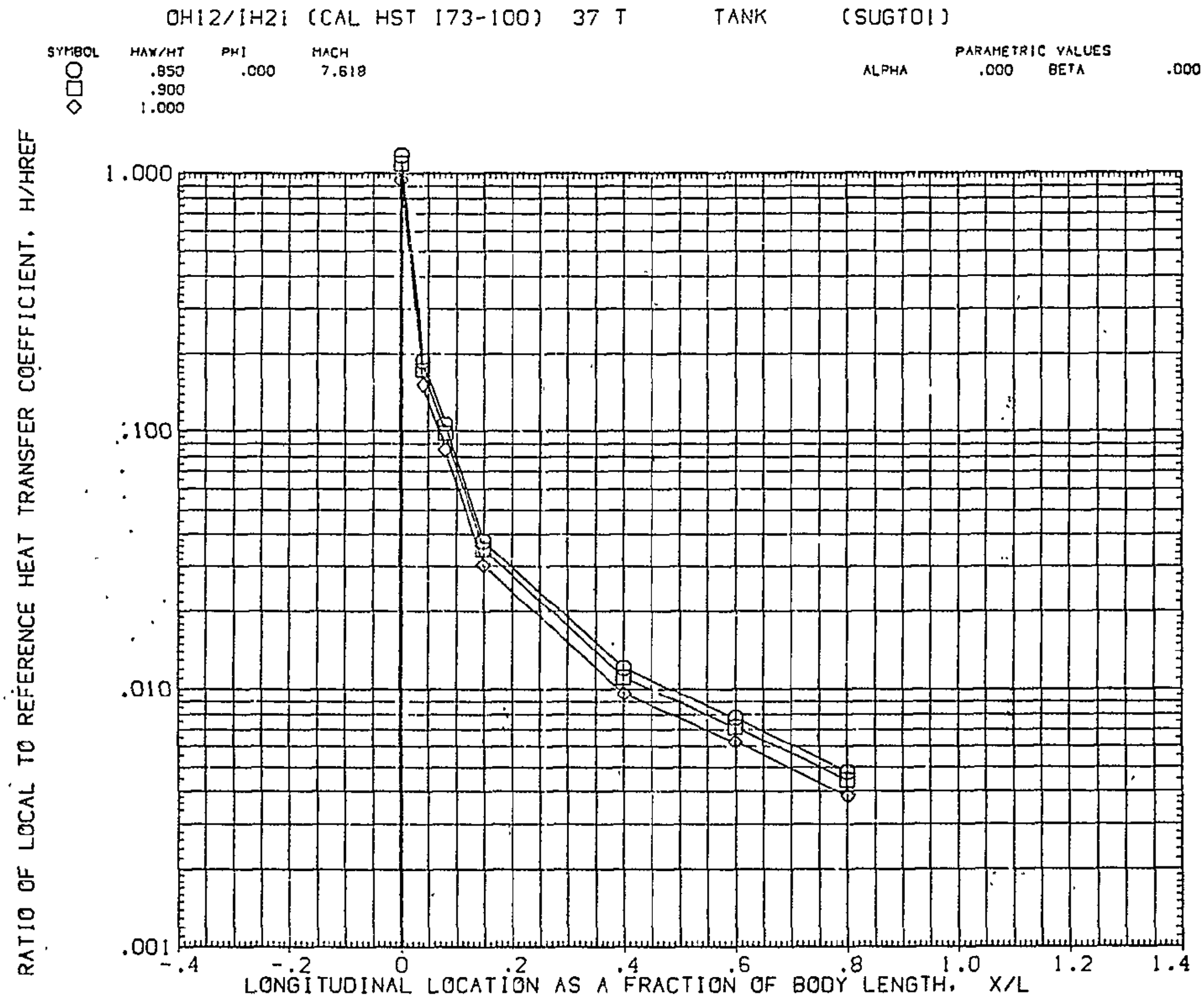


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)

SYMBOL	HAW/HT	PHI	MACH
○	.850	180.000	7.618
□	.900		
◇	1.000		

PARAMETRIC VALUES

ALPHA .000 BETA .000

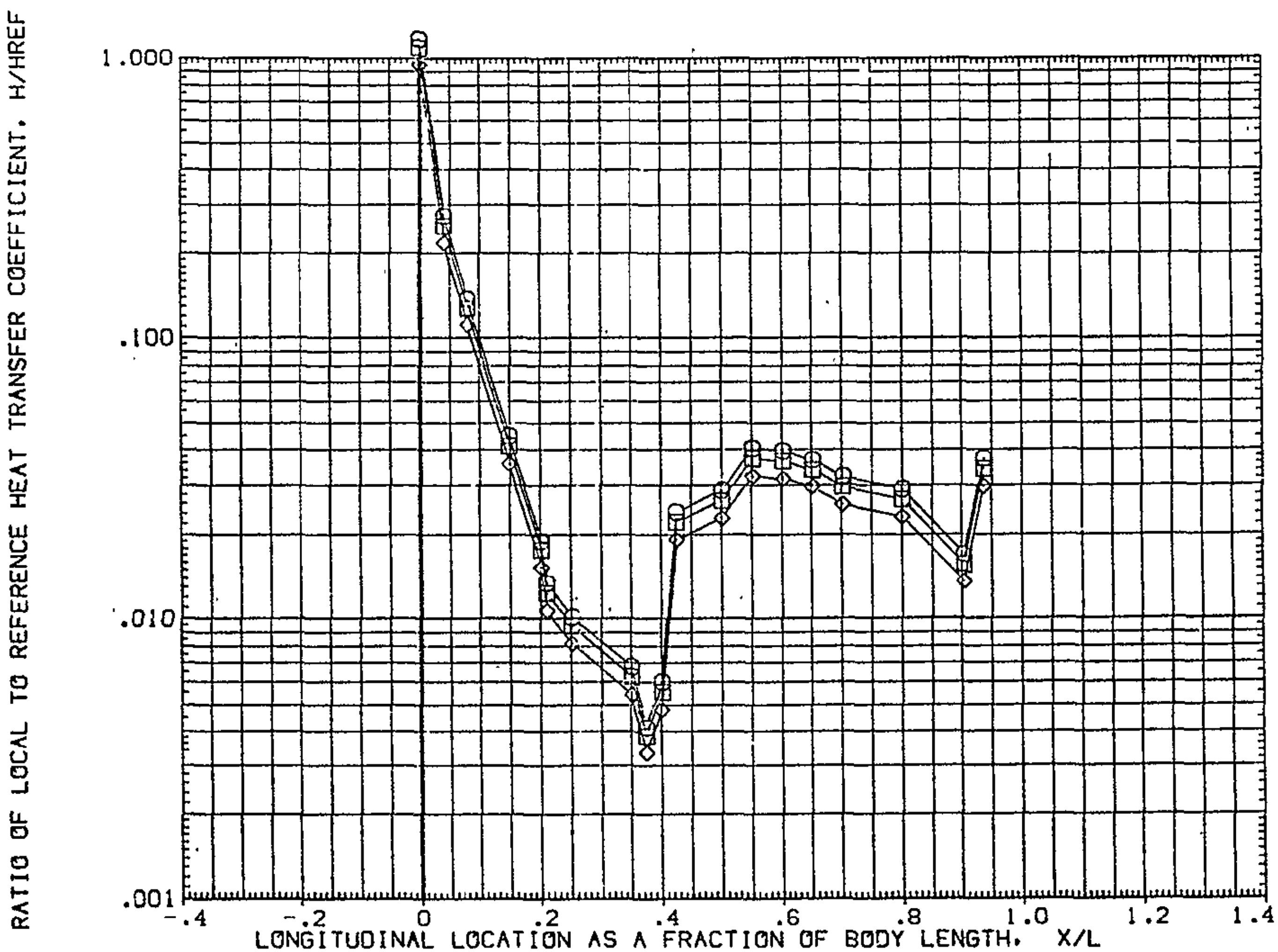


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0H12/1H21 (CAL HST I73-100) 37 T TANK (SUGT01)

SYMBOL	HAW/HT	PHI	MACH
○	.850	199.000	7.618
□	.900		
◇	1.000		

PARAMETRIC VALUES

ALPHA .000 BETA .000

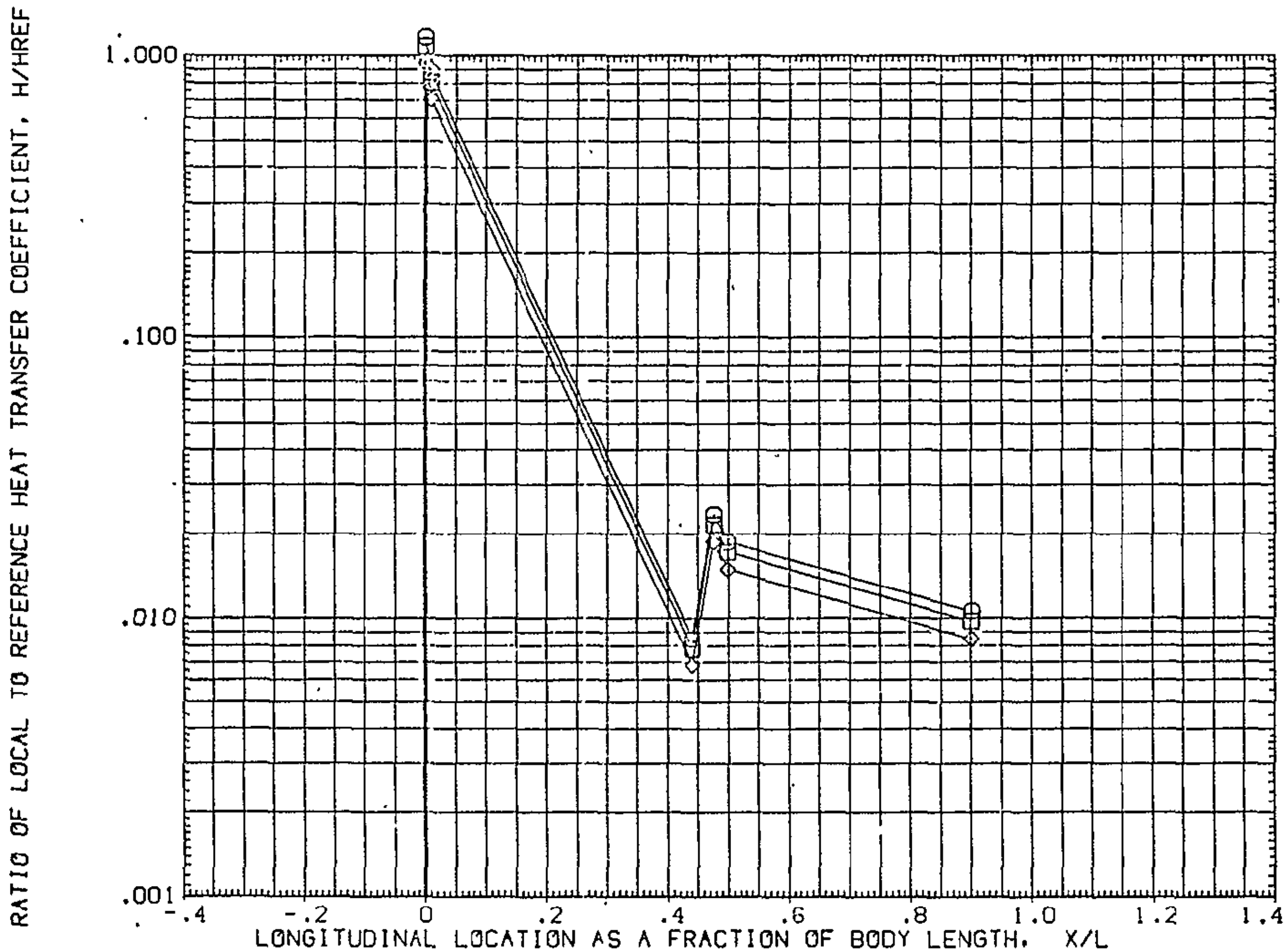
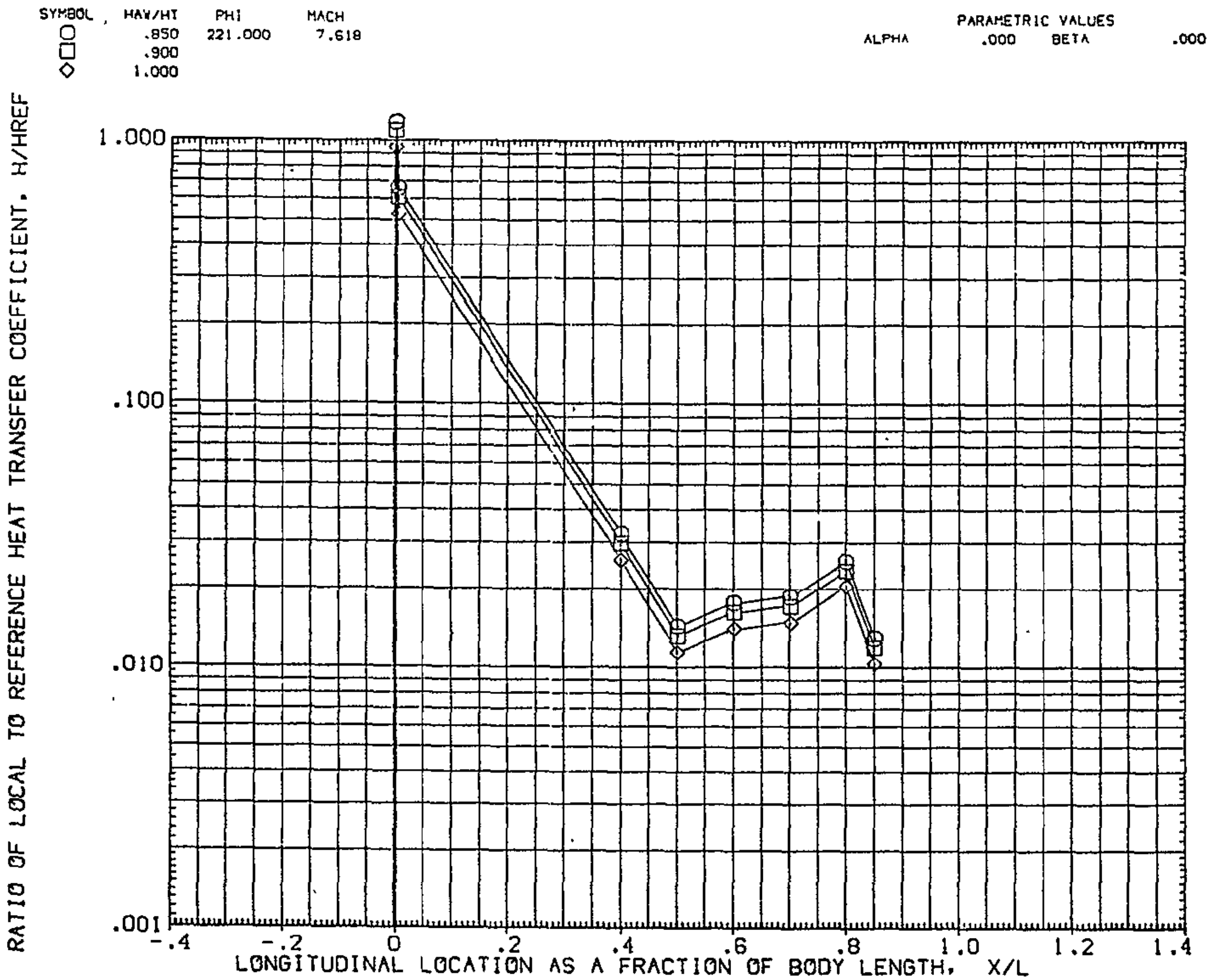


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T   TANK   (SUGT01)



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OH12/IH21 (CAL HST 173-100) 37 T TANK (SUGT01)

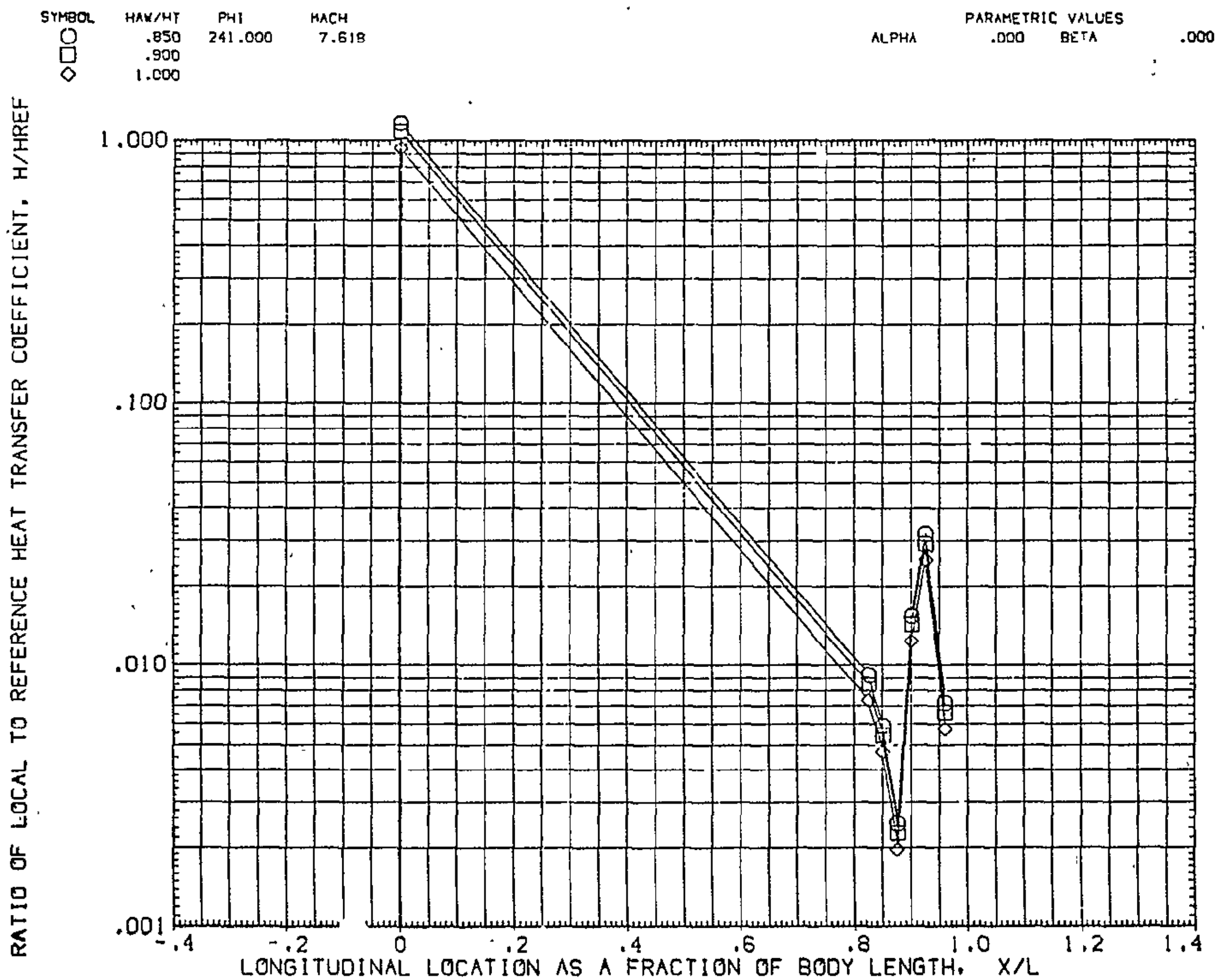


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)

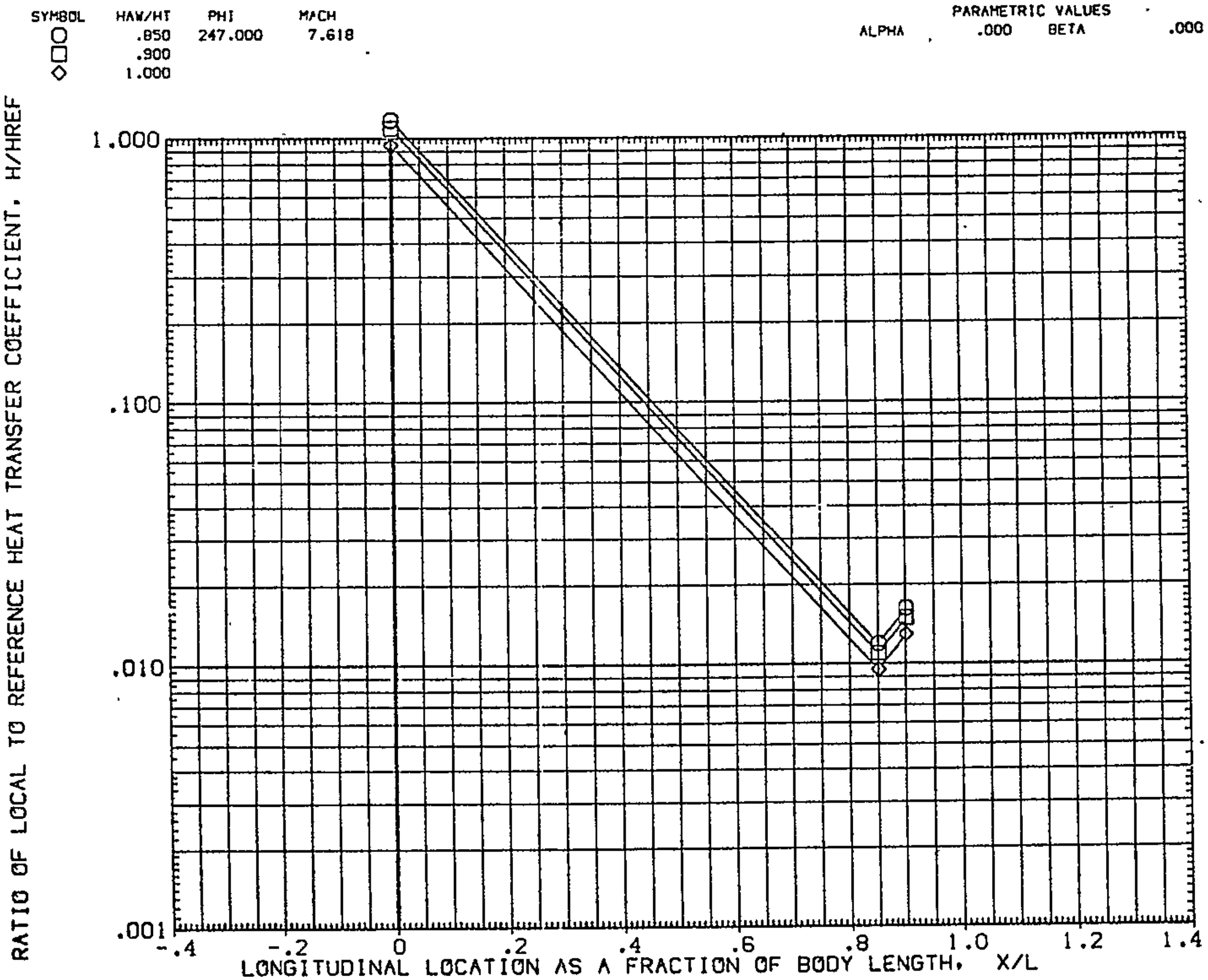


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

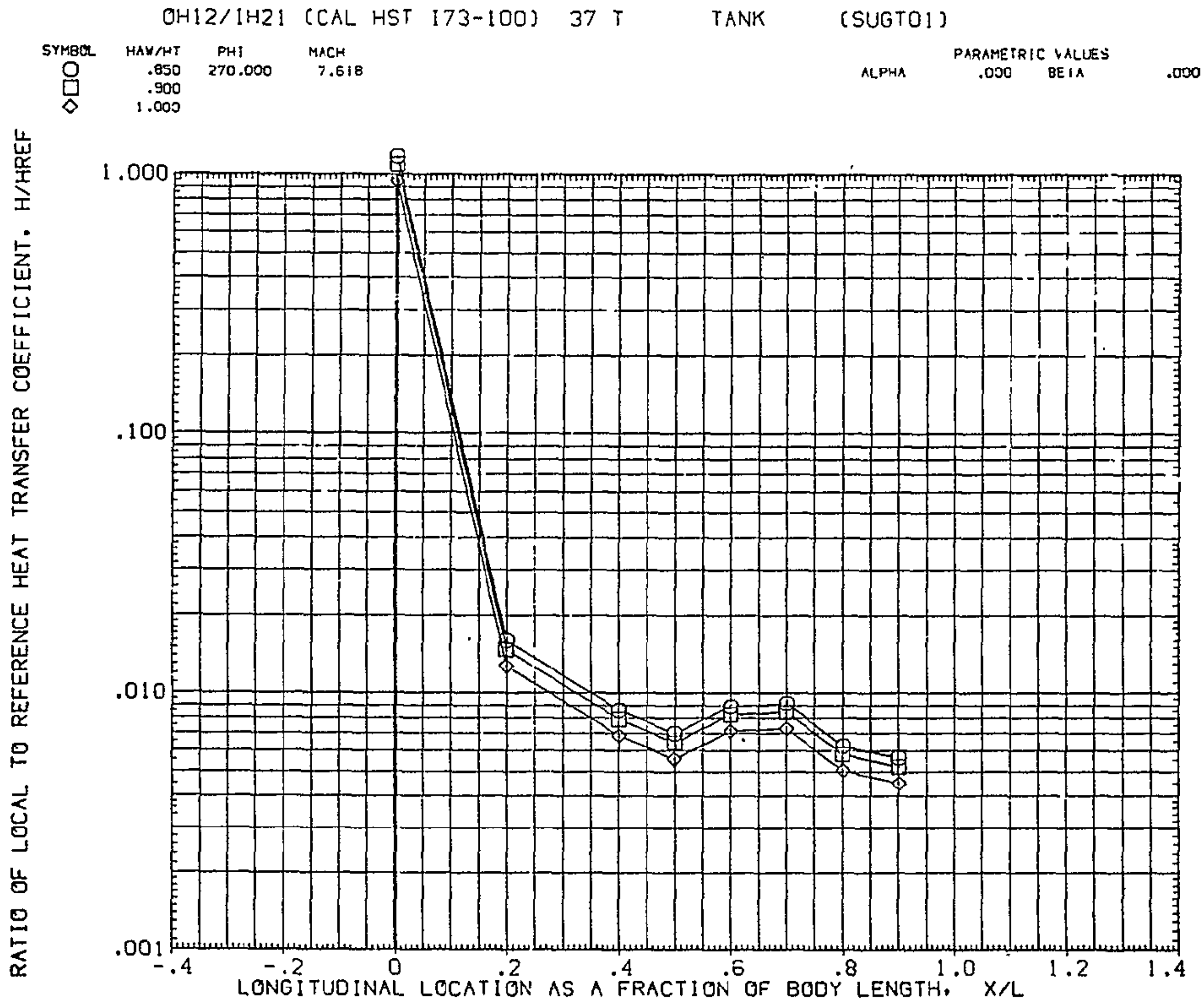


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

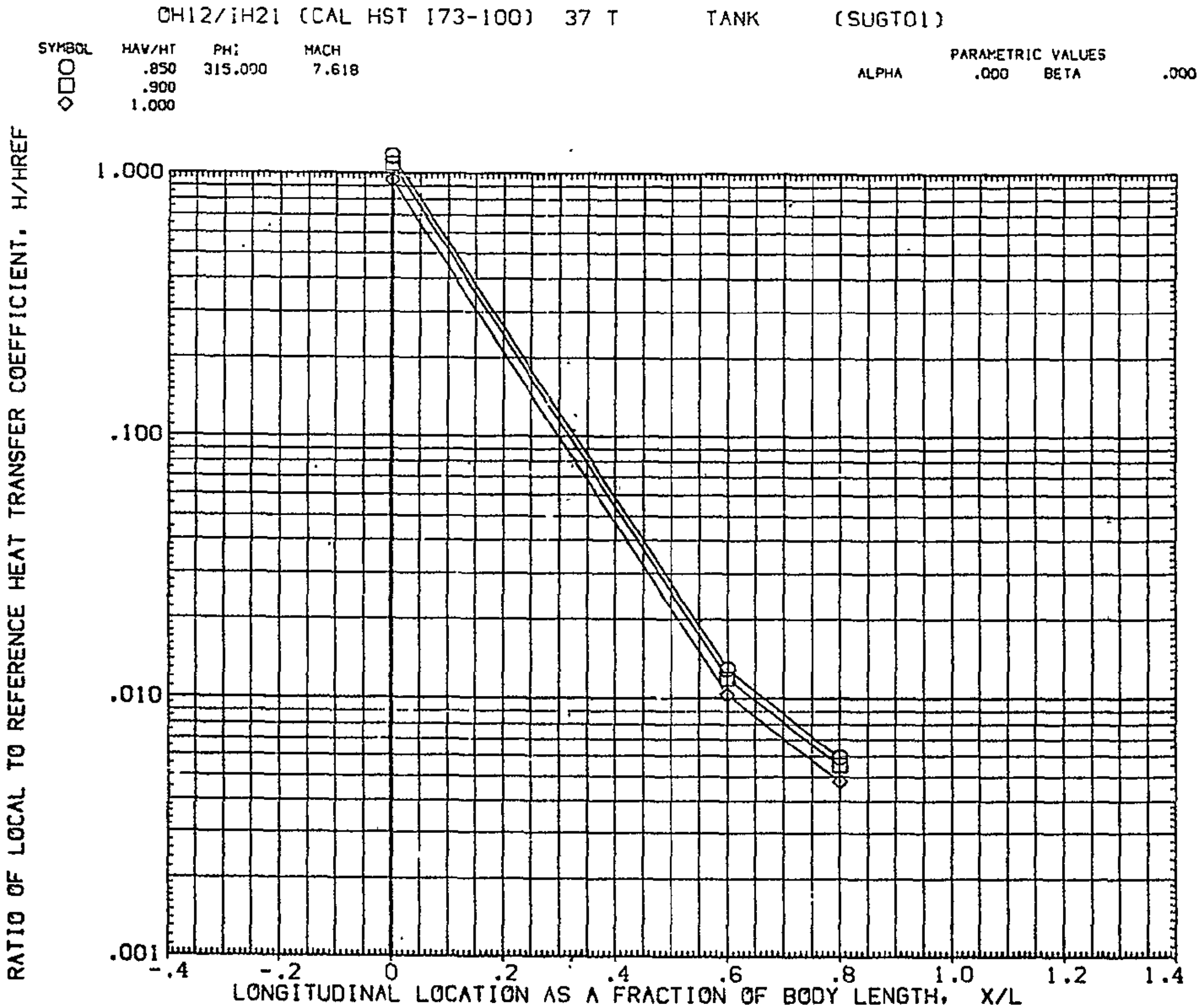


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

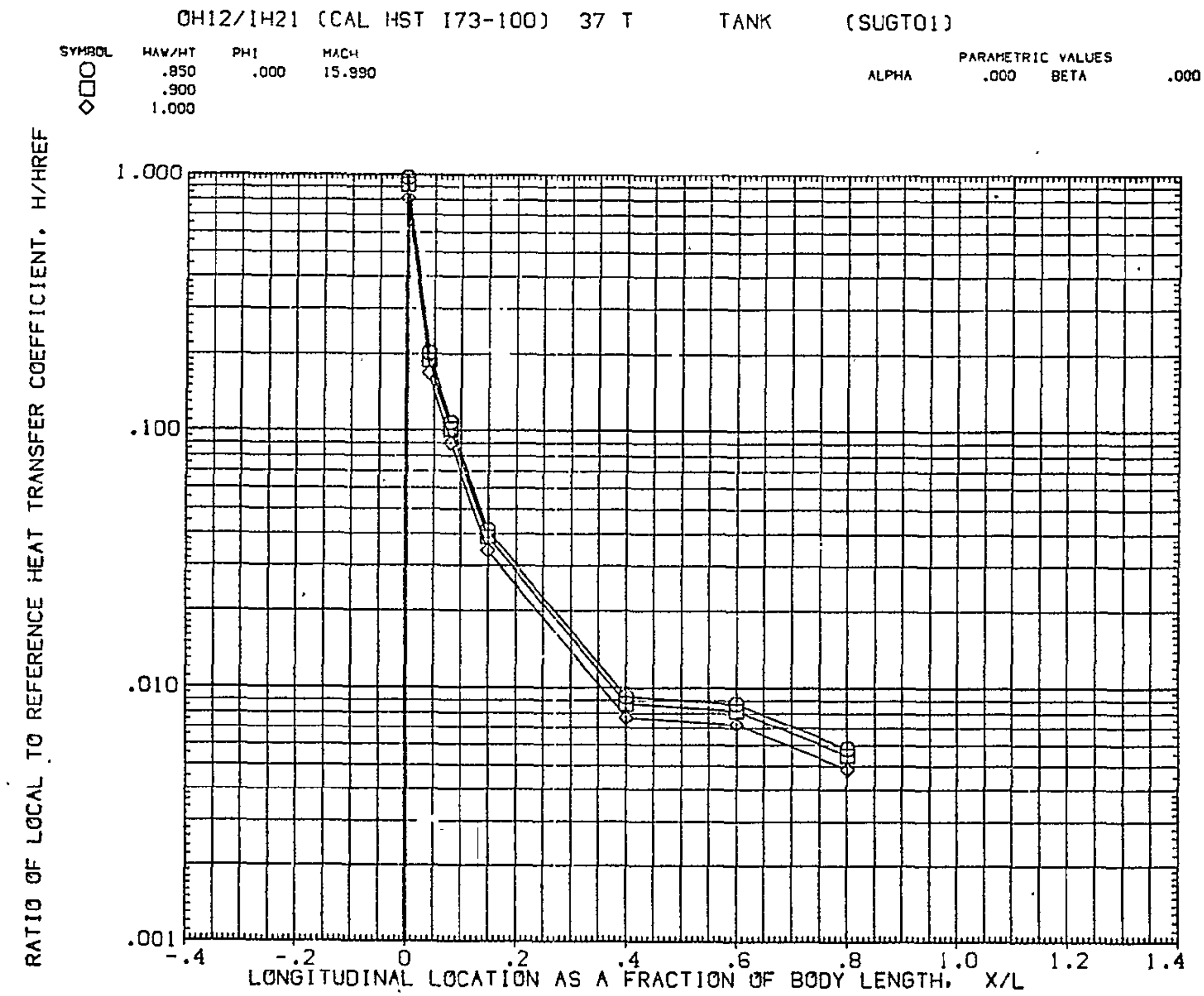


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

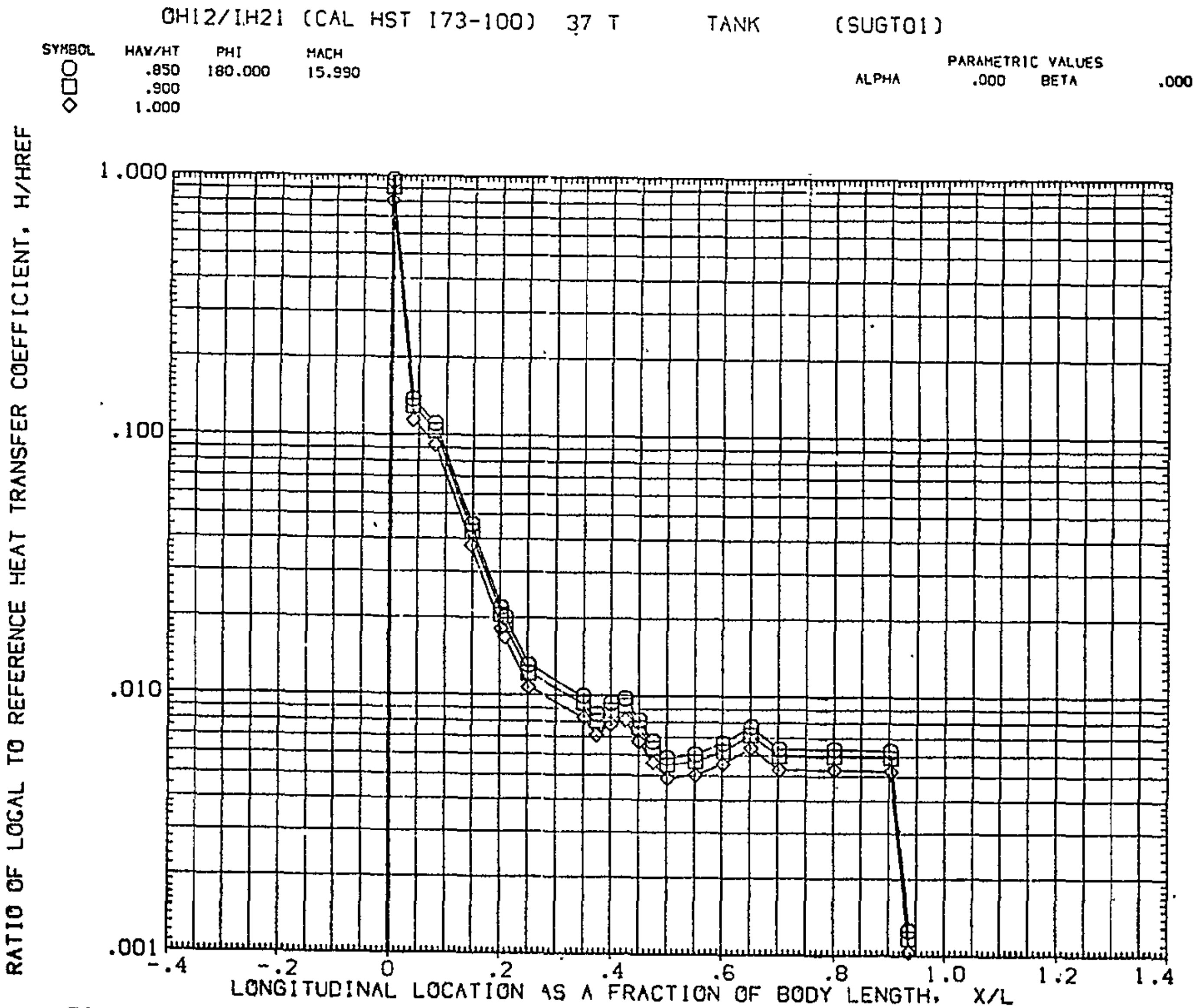


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

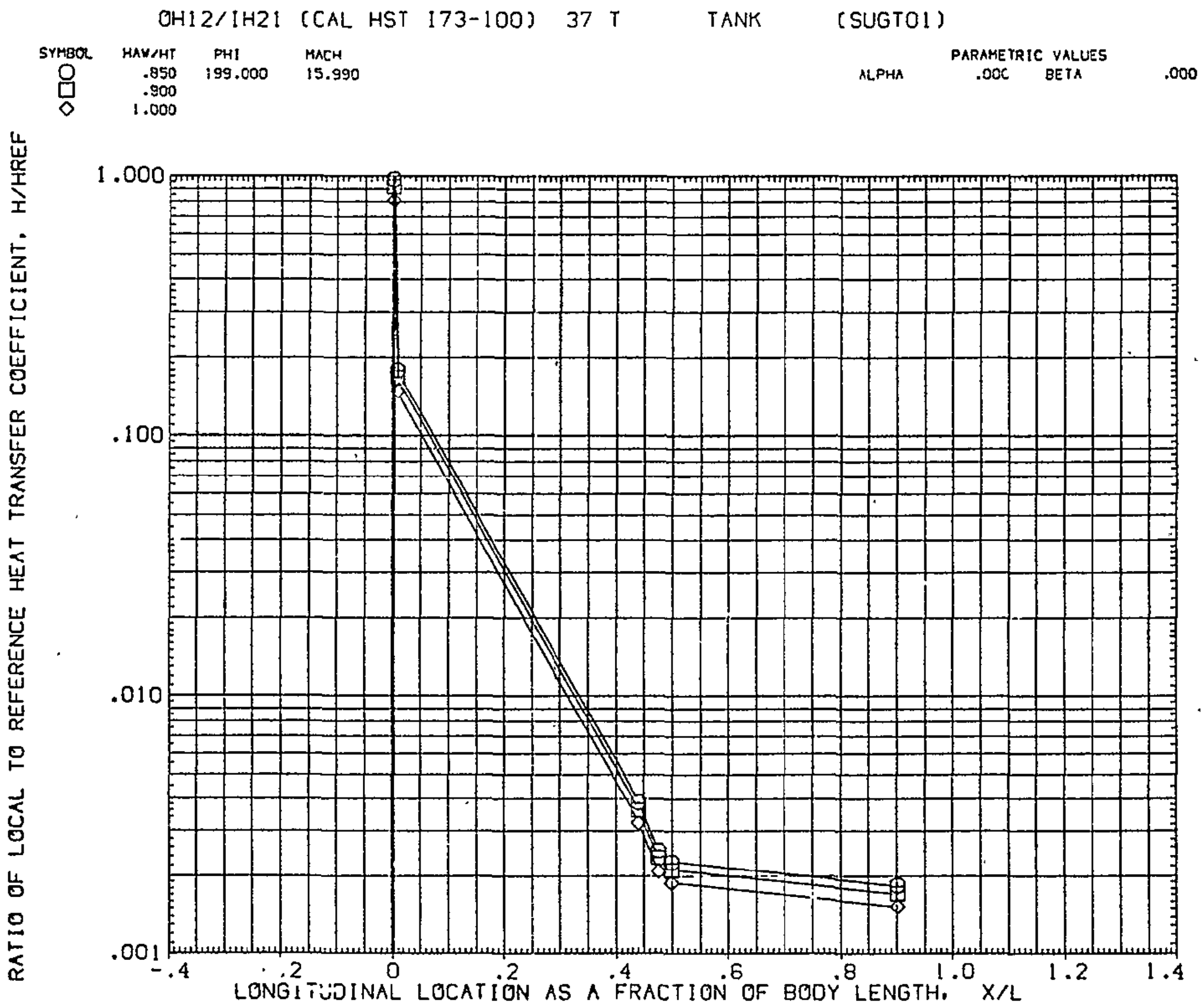


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

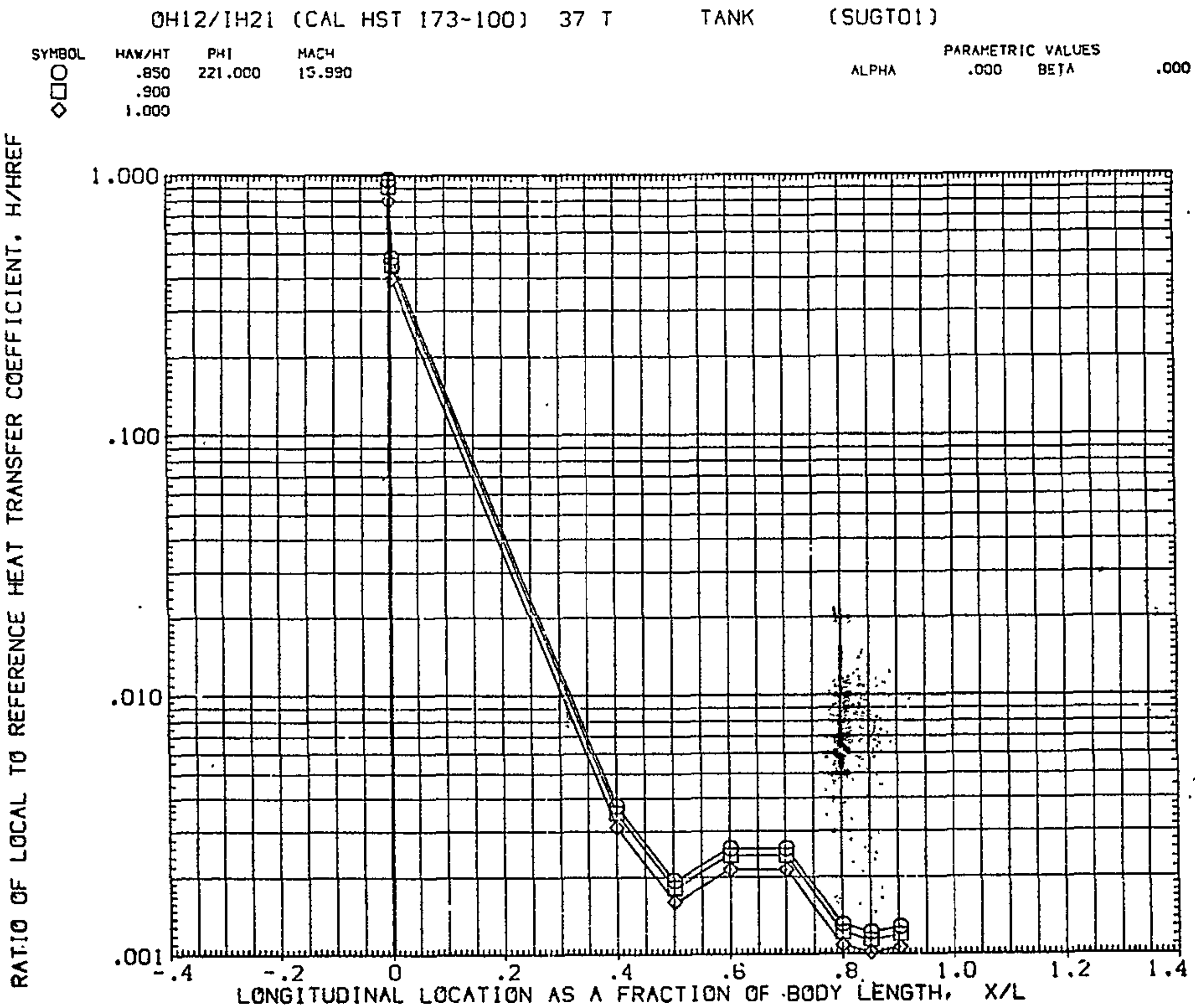


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

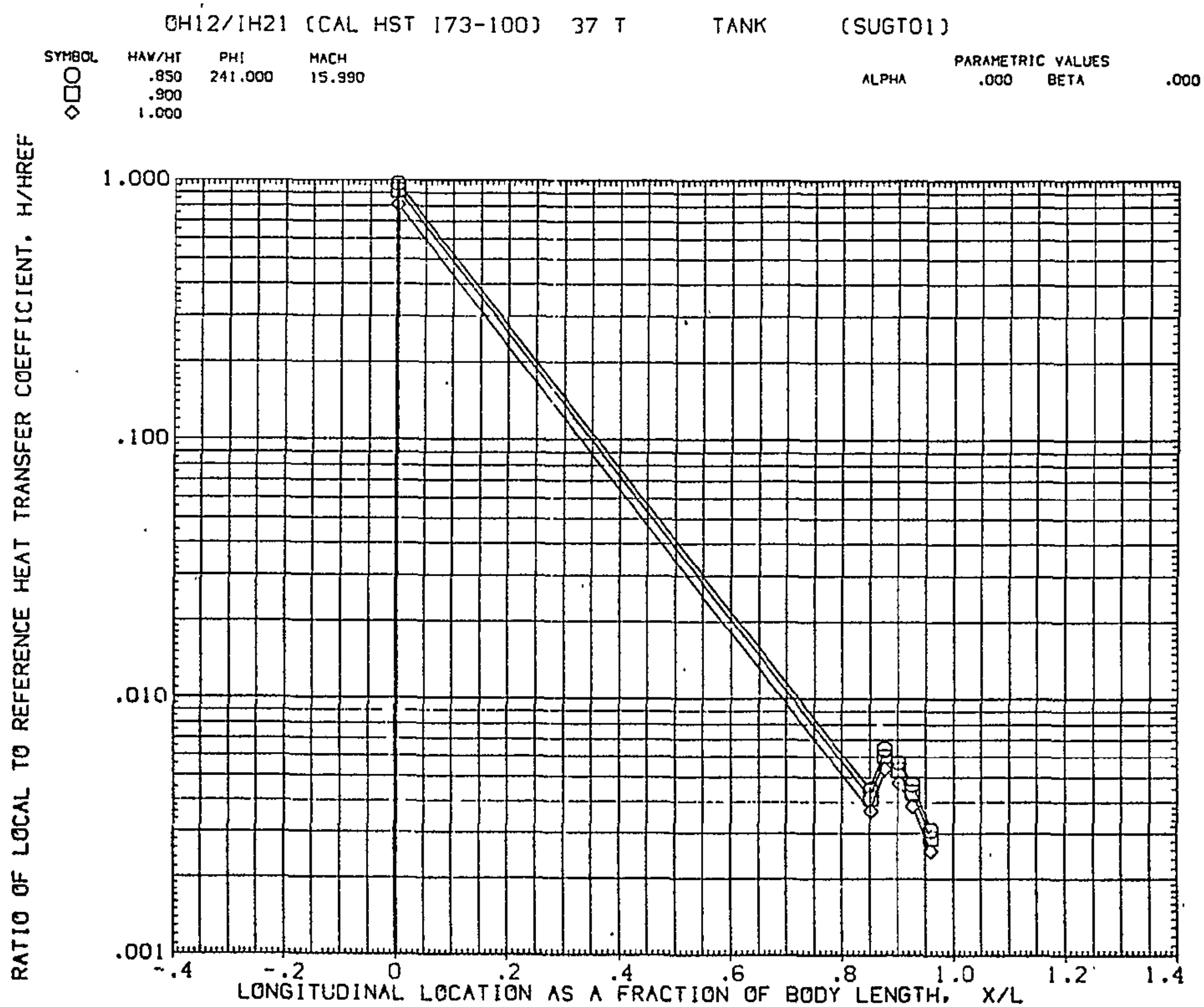


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)

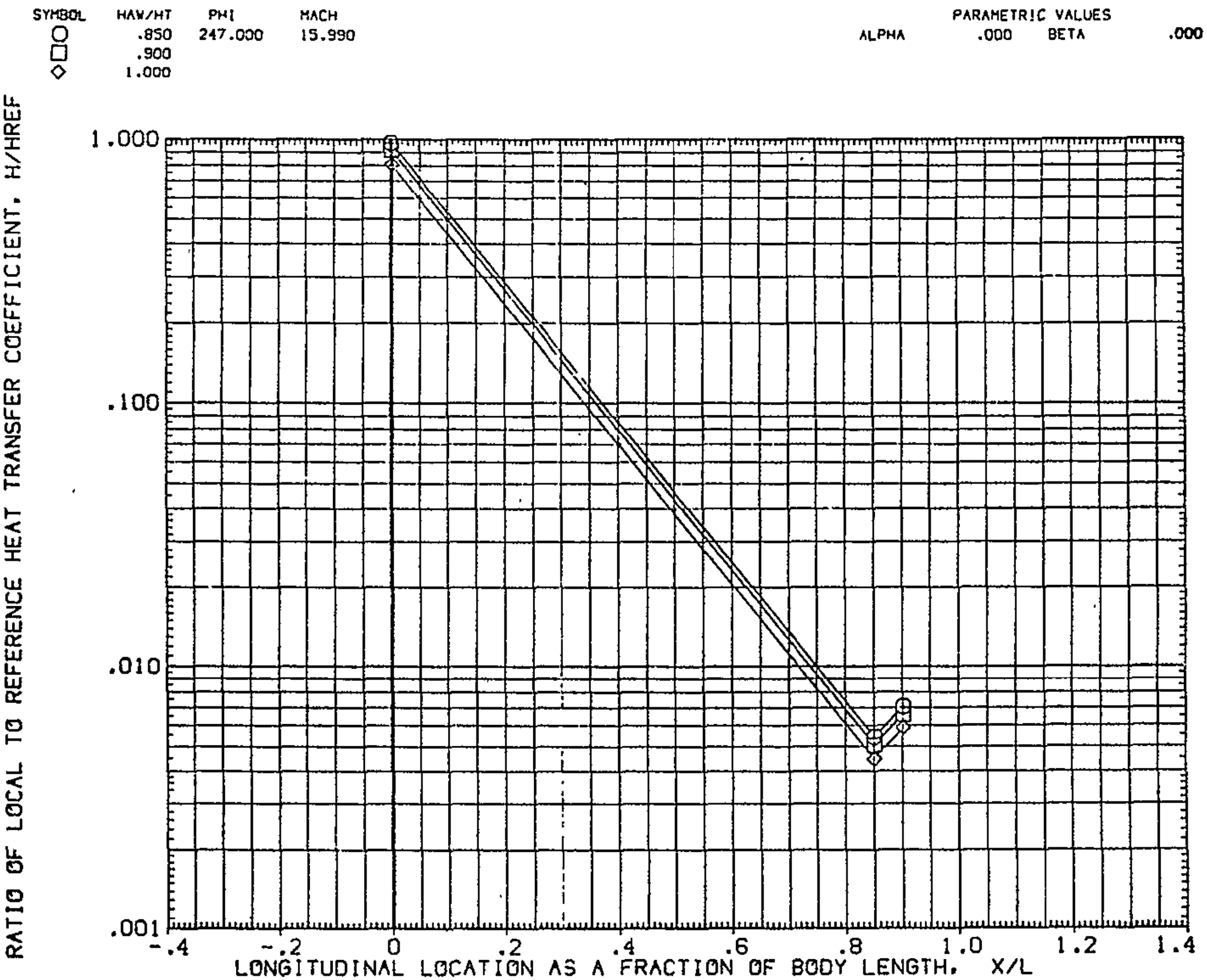


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

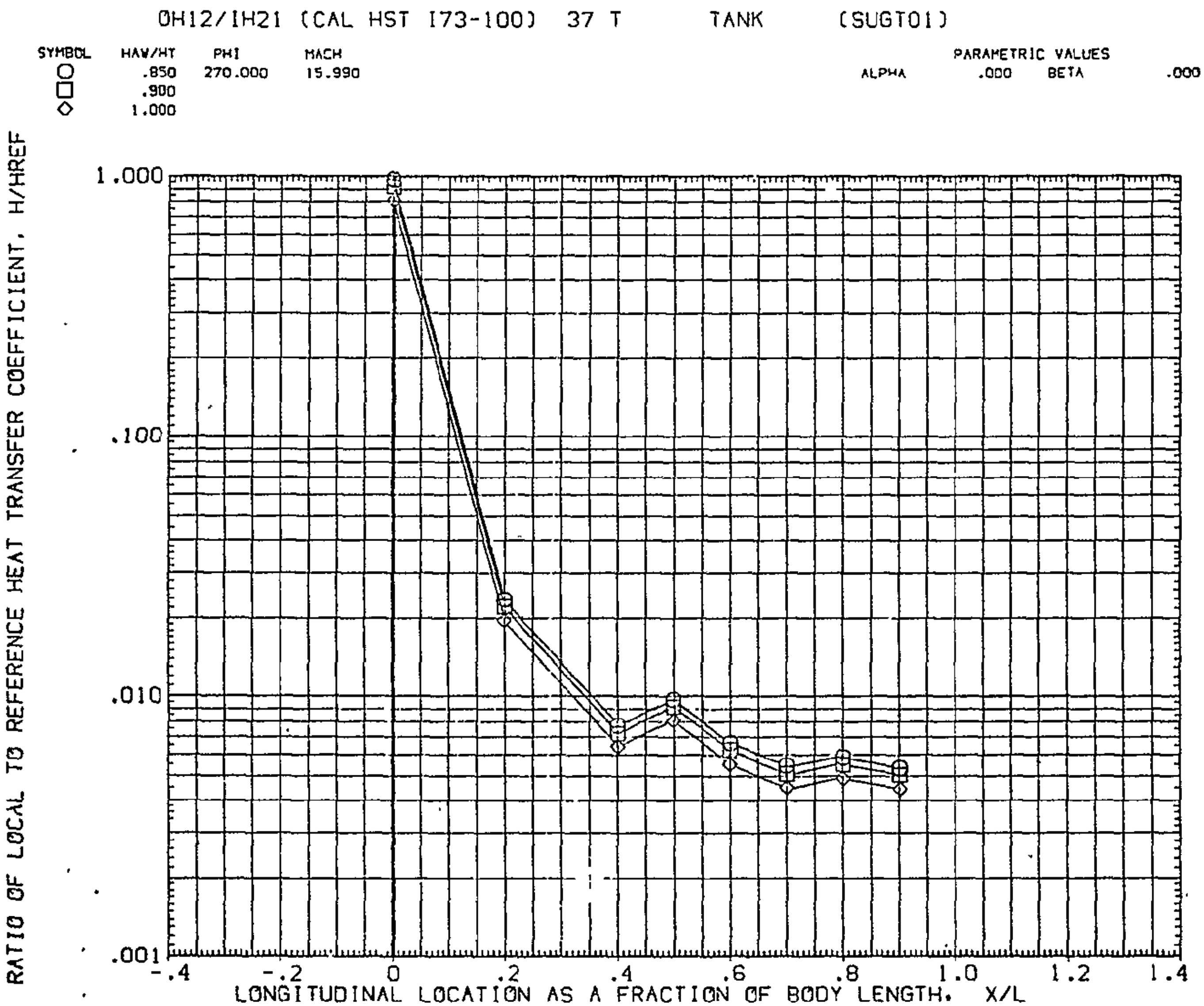


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 T TANK (SUGT01)

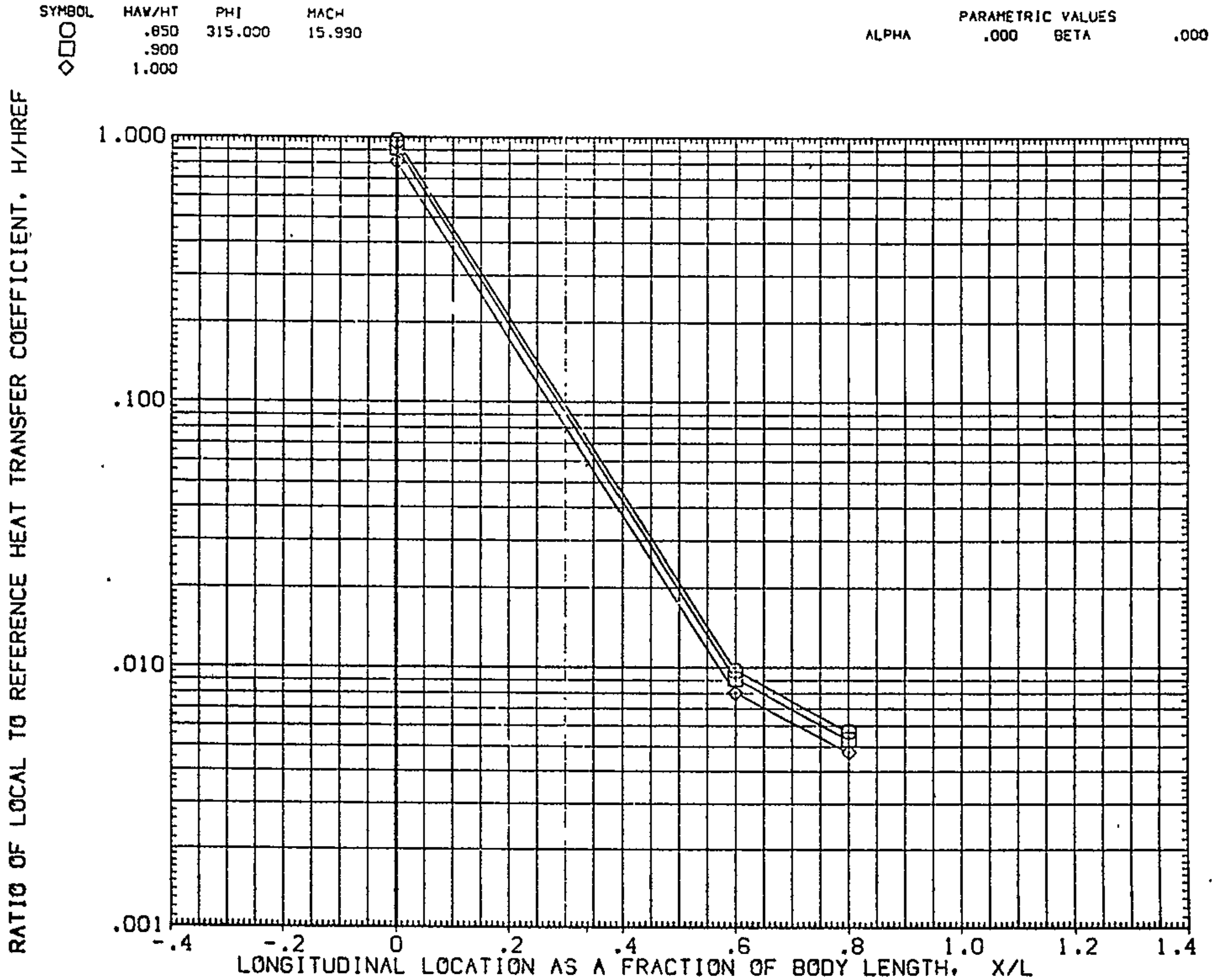


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 T TANK (SUGT01)

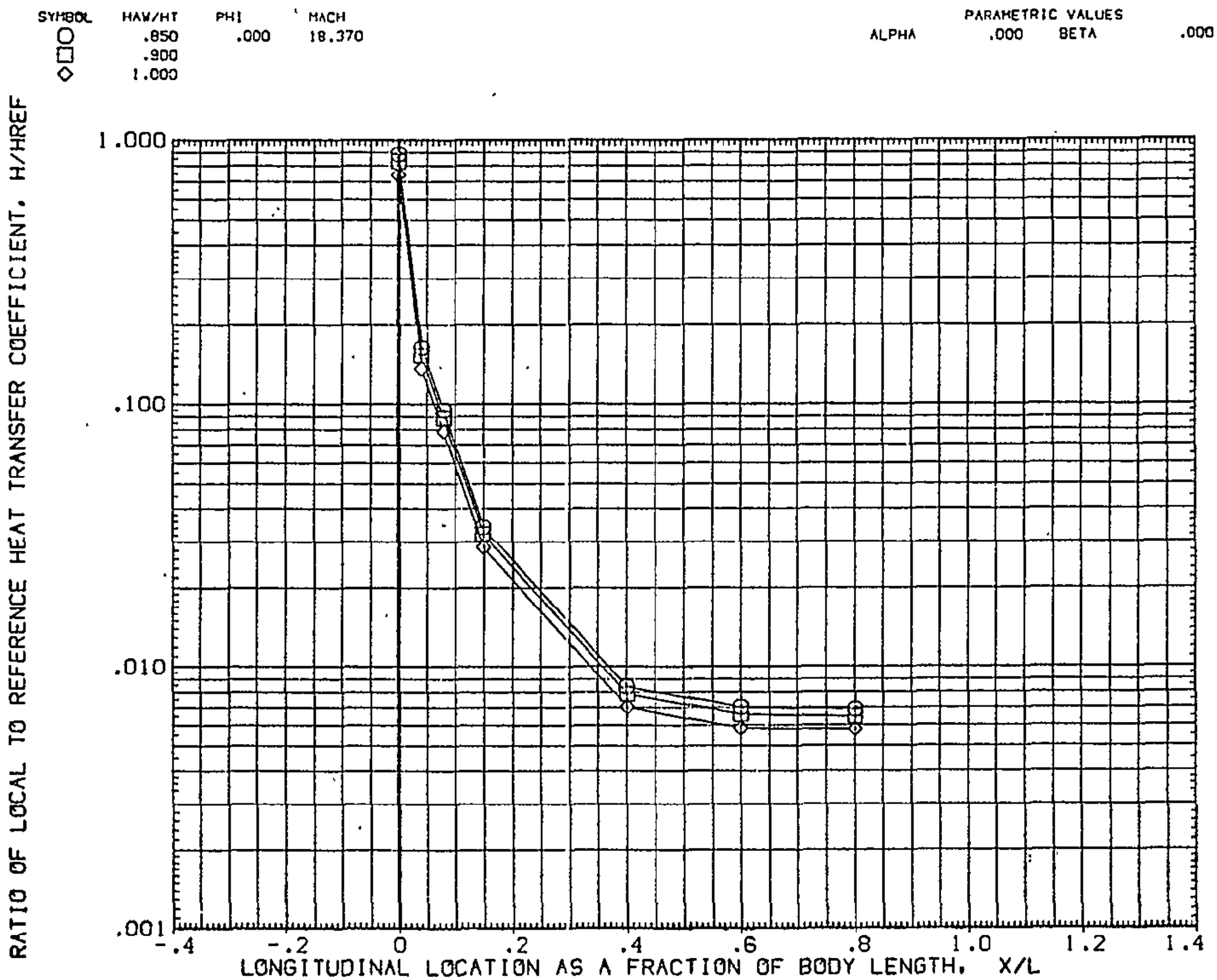


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

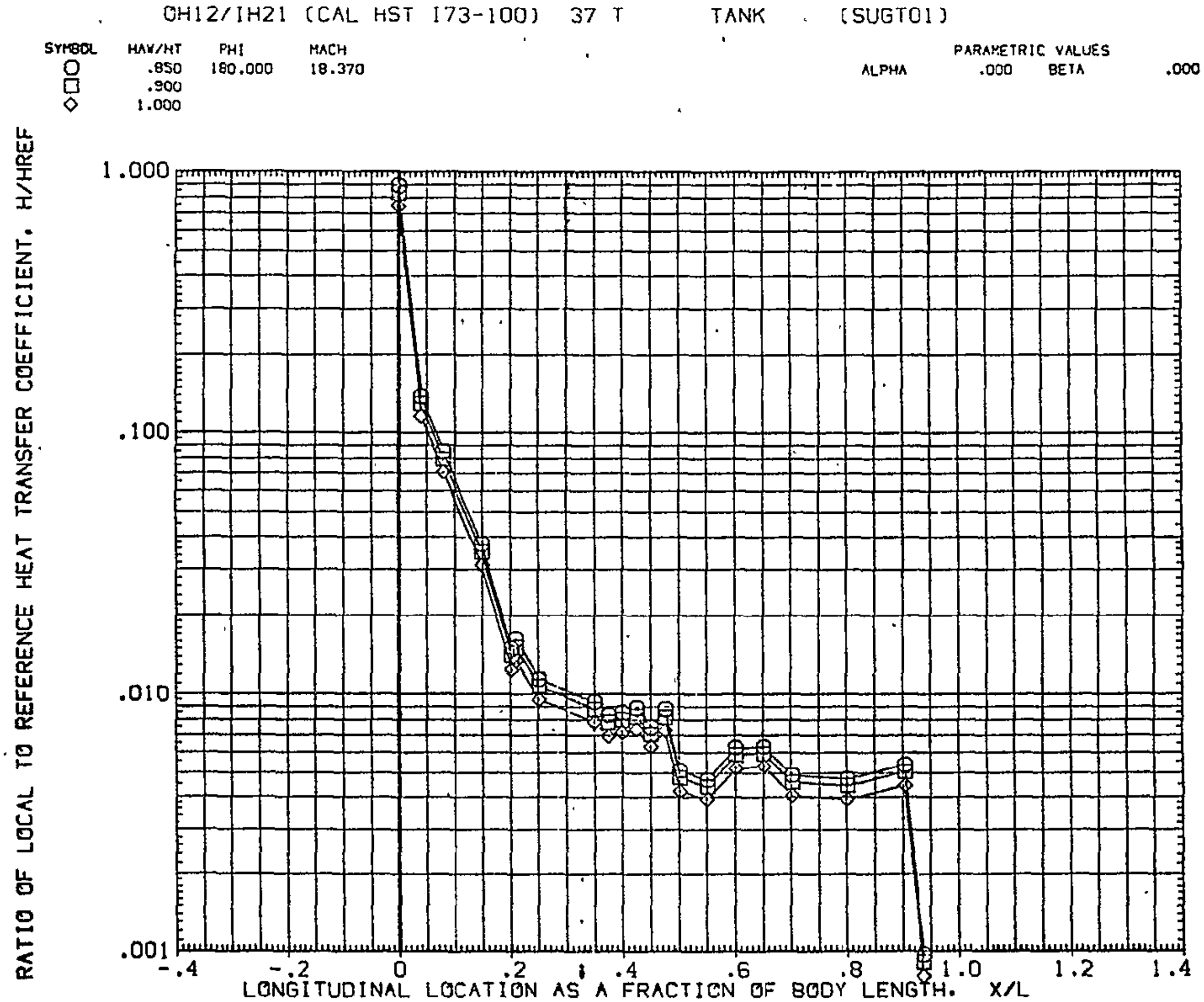


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

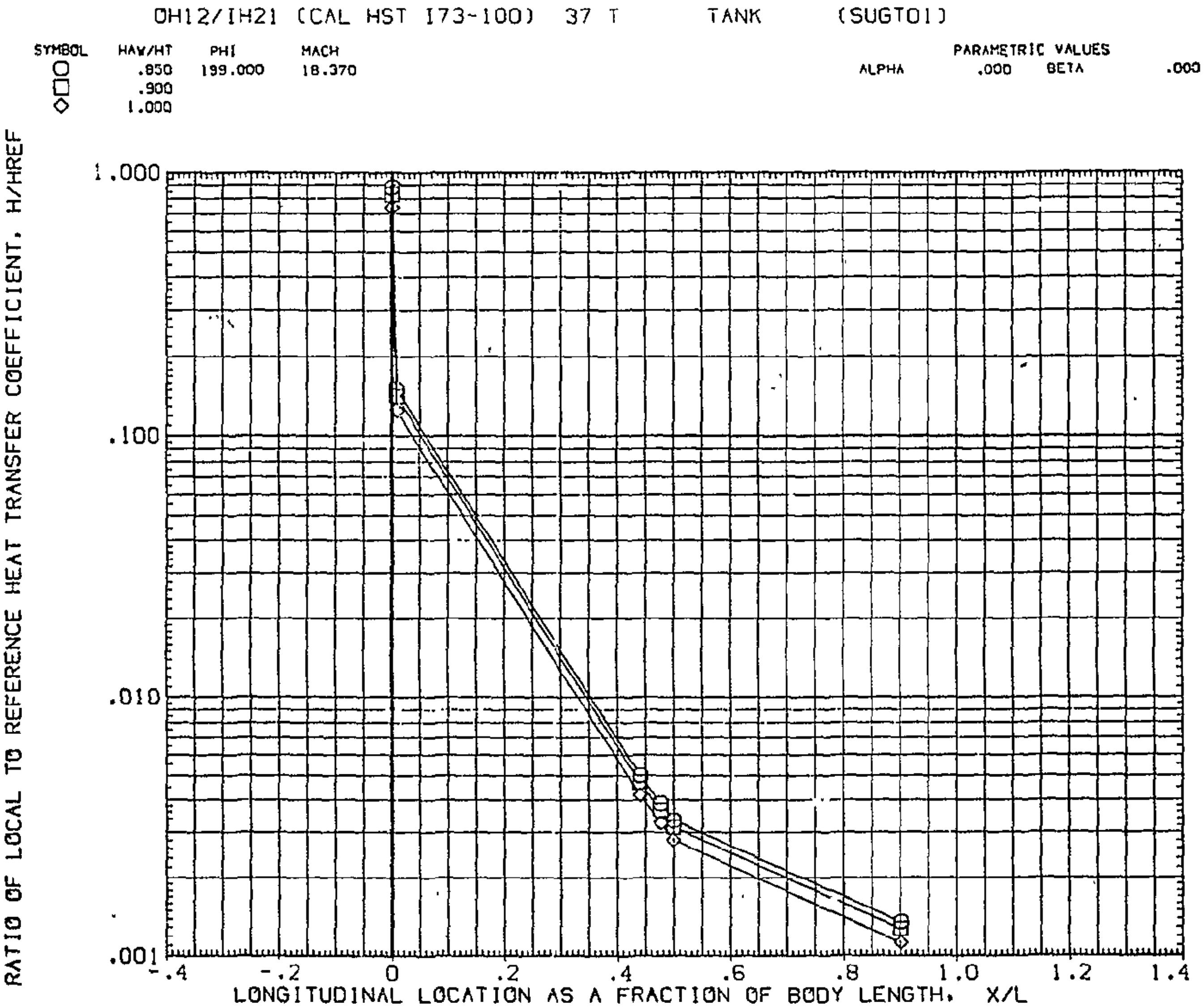


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

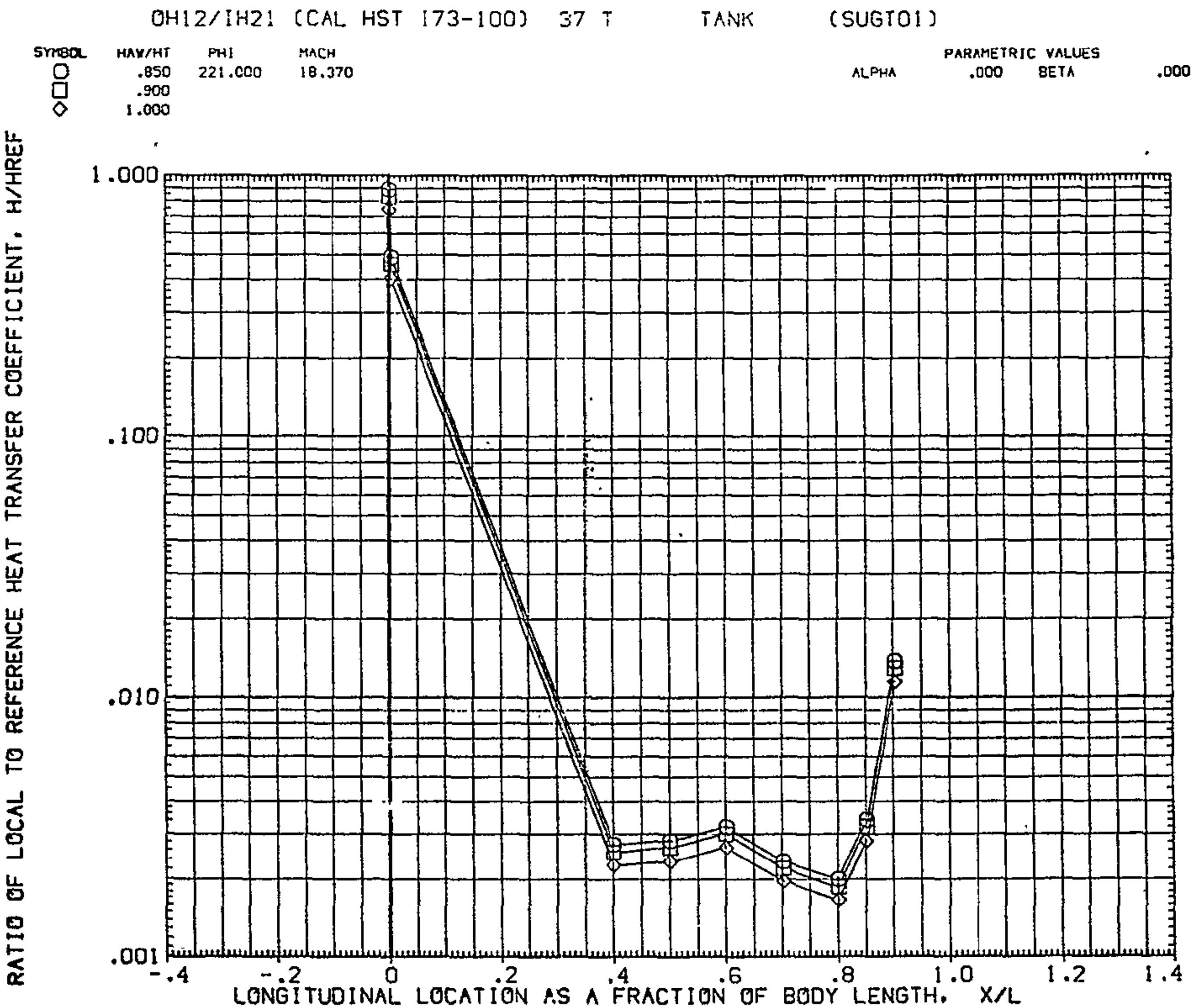


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

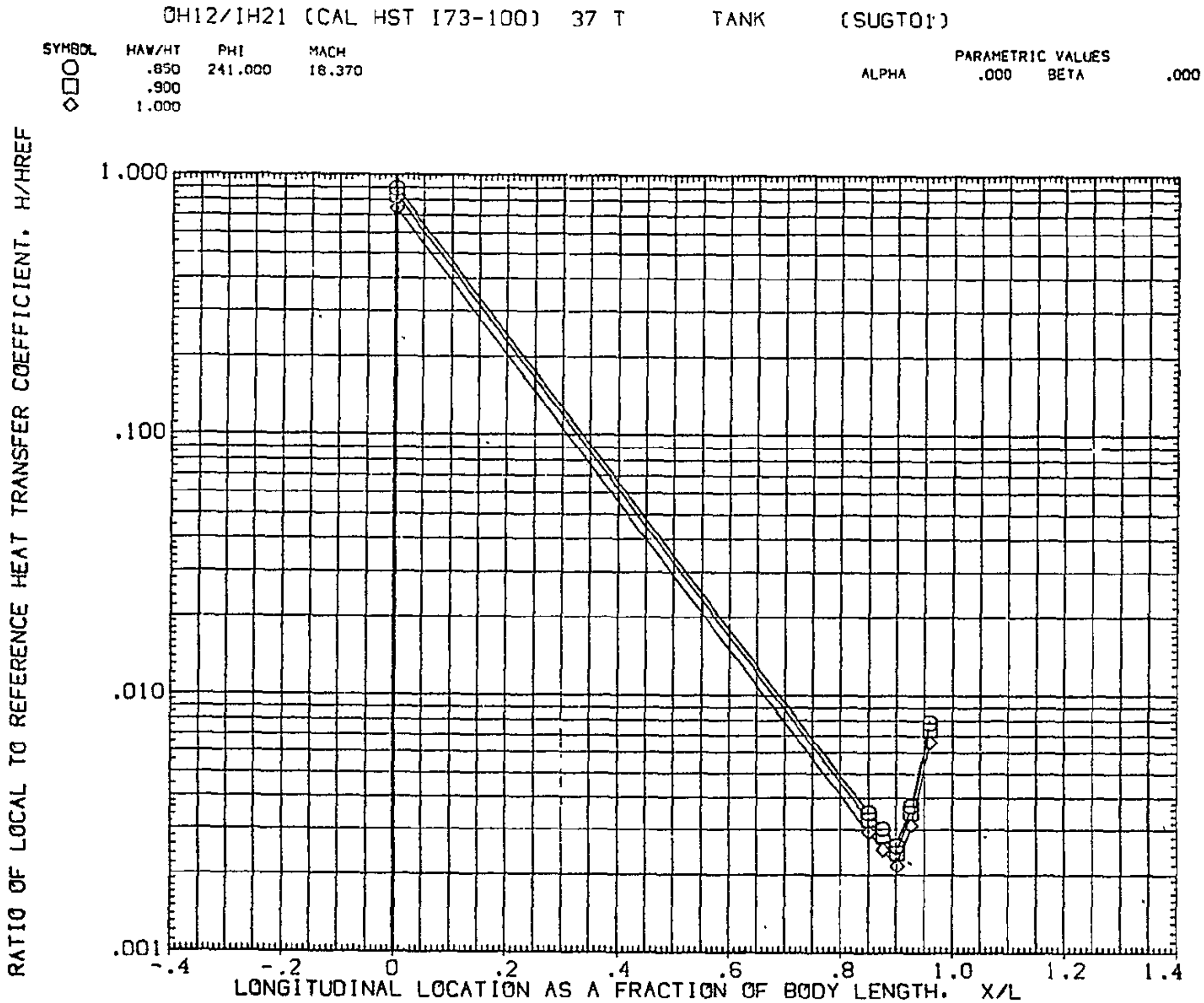


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 T TANK (SUGT01)

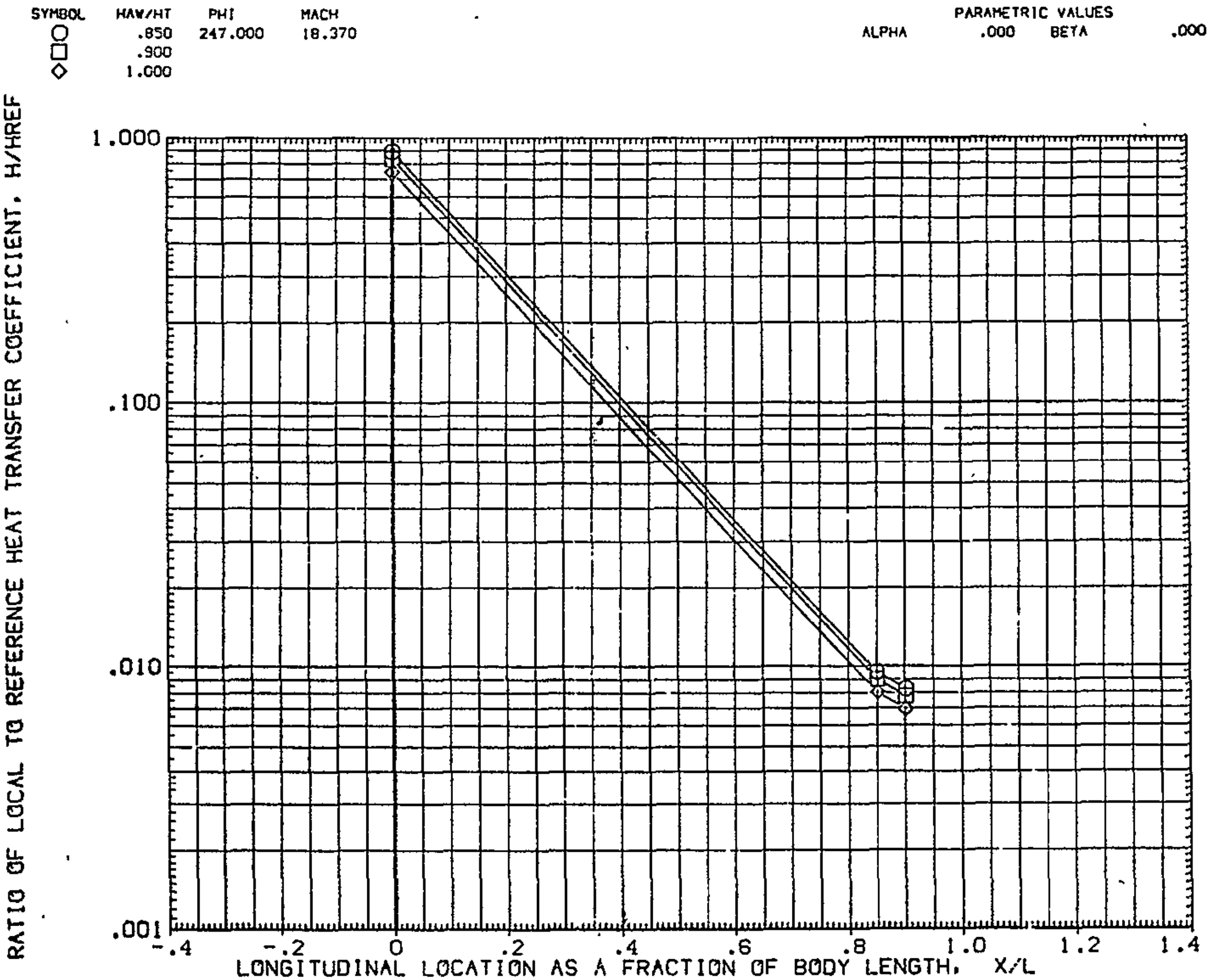


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

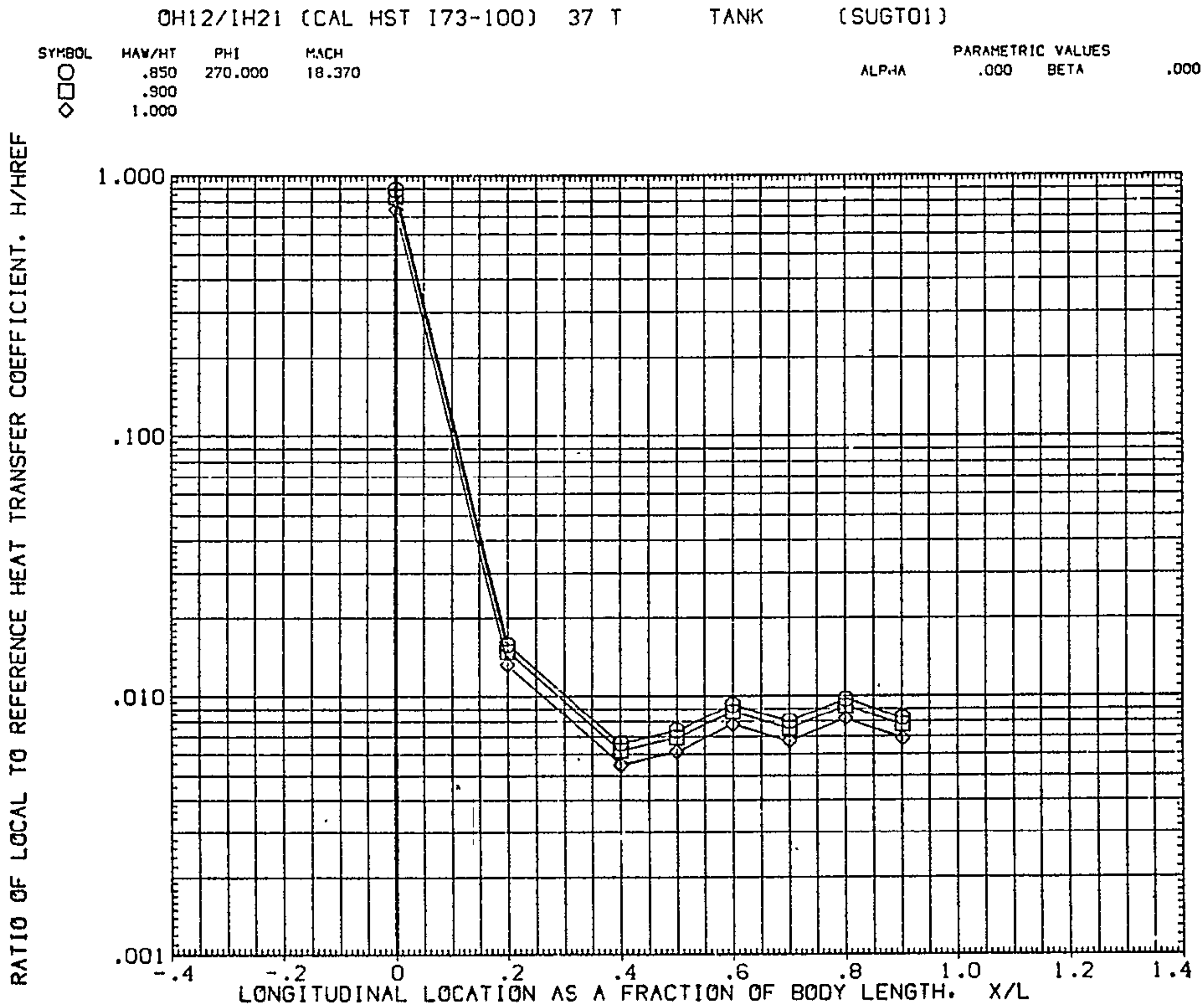


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

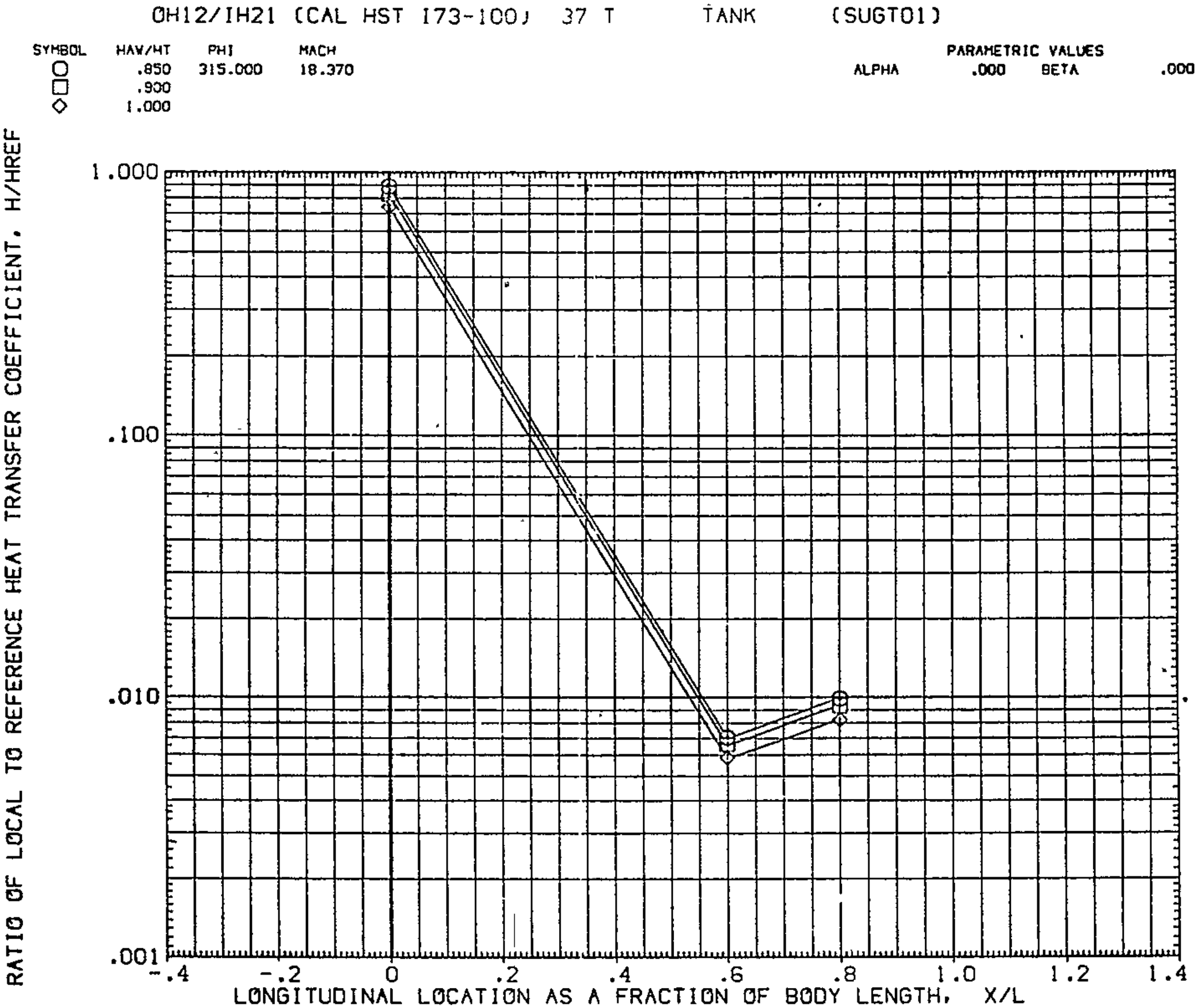


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

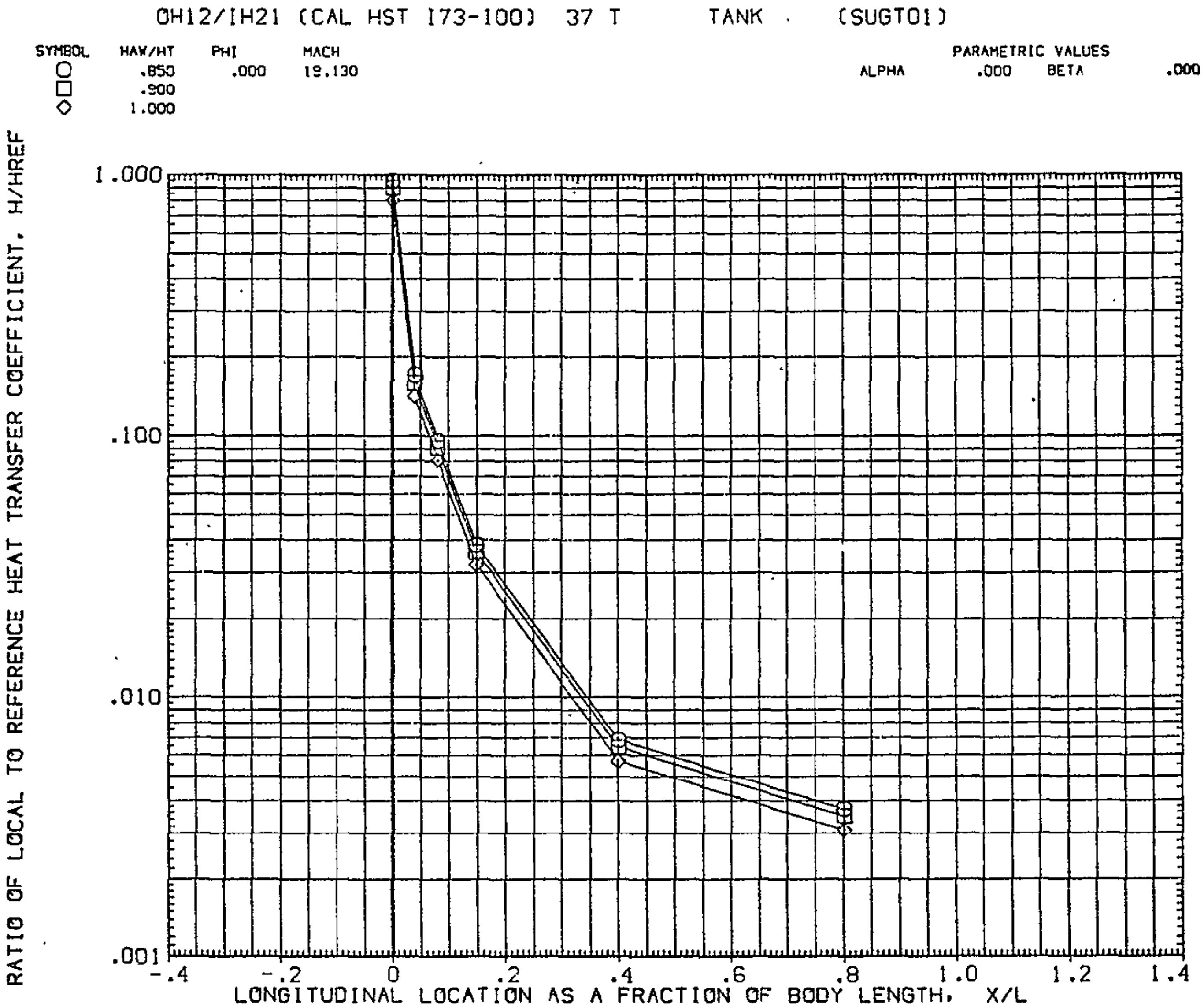


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

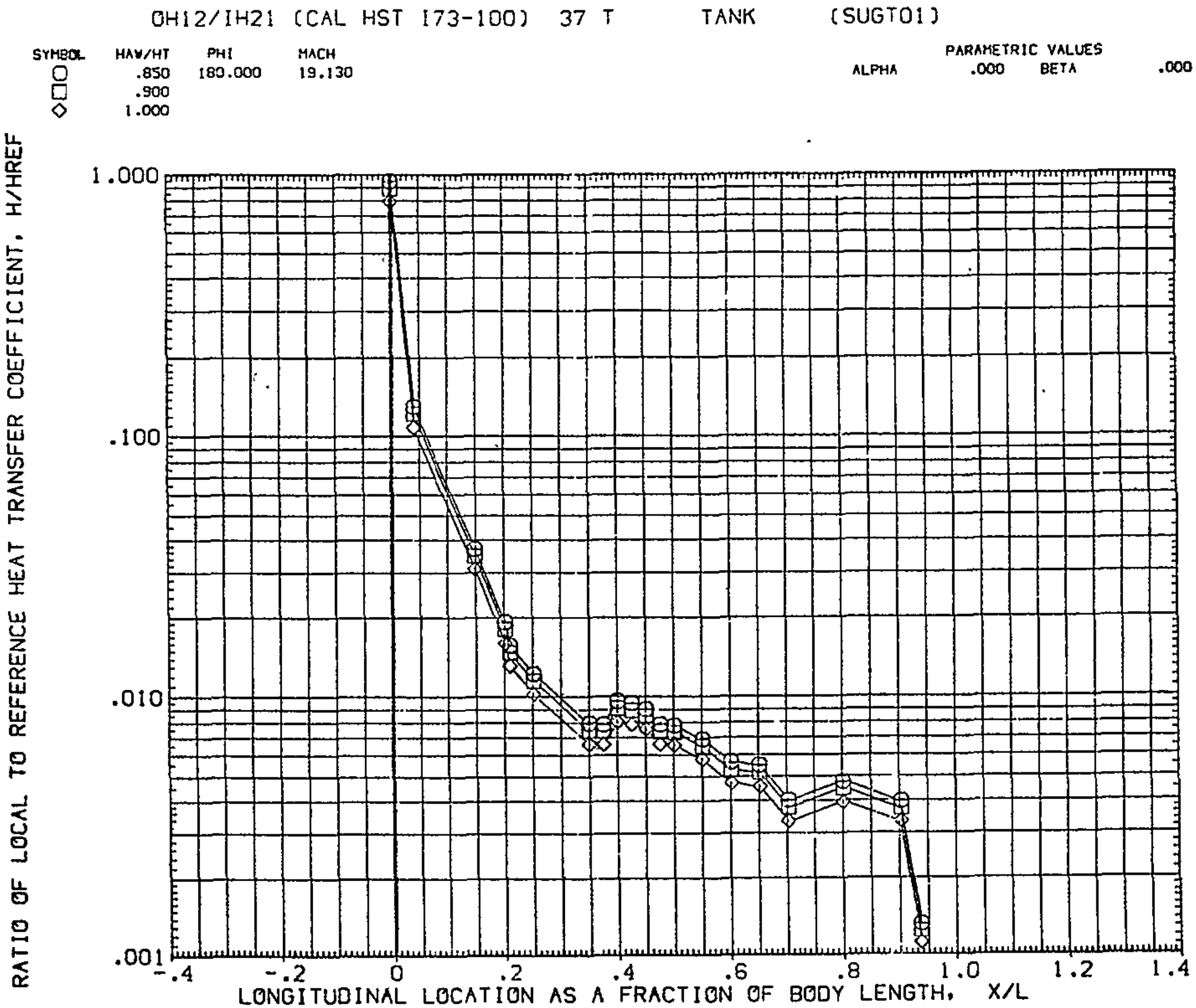


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

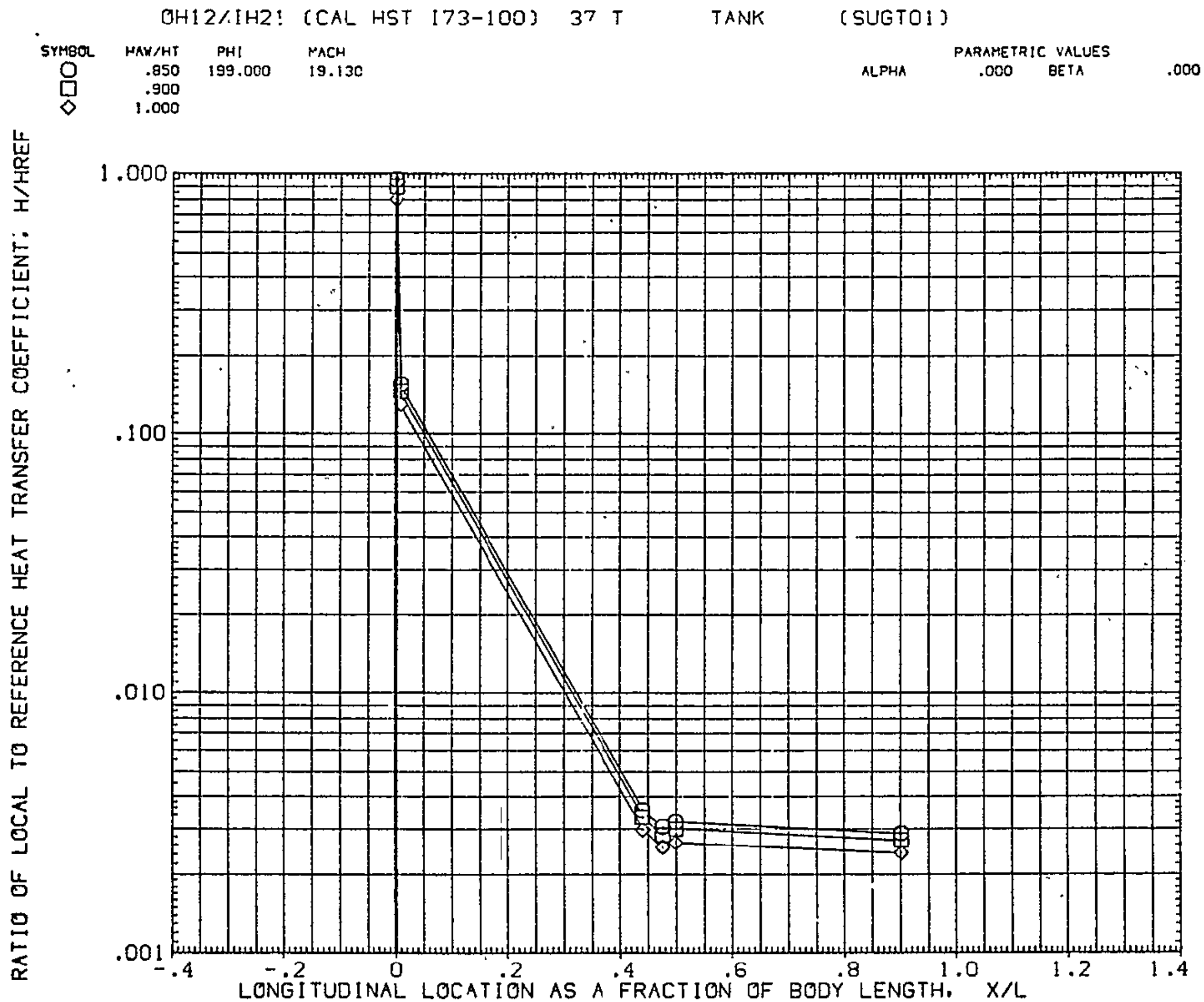


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

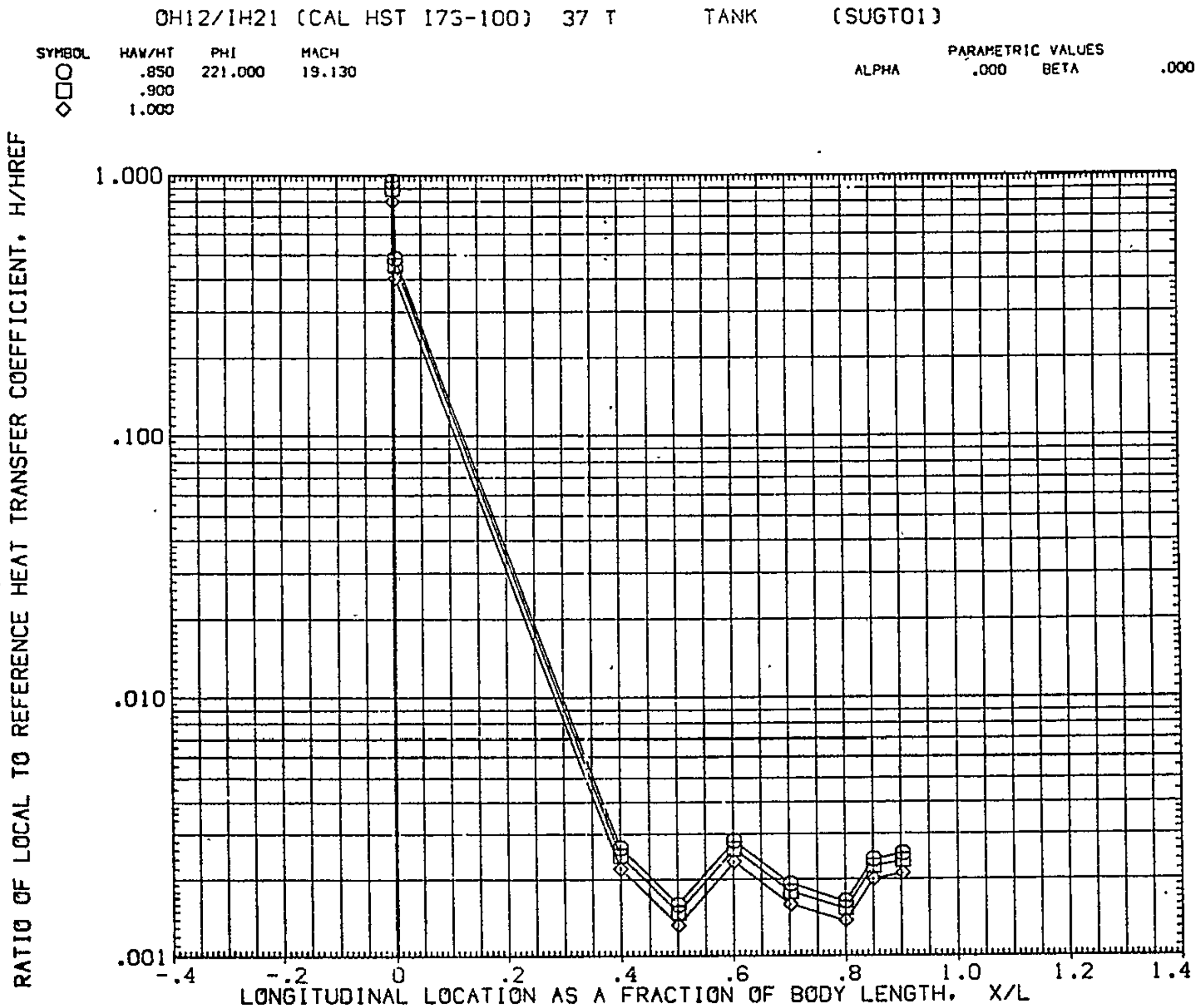
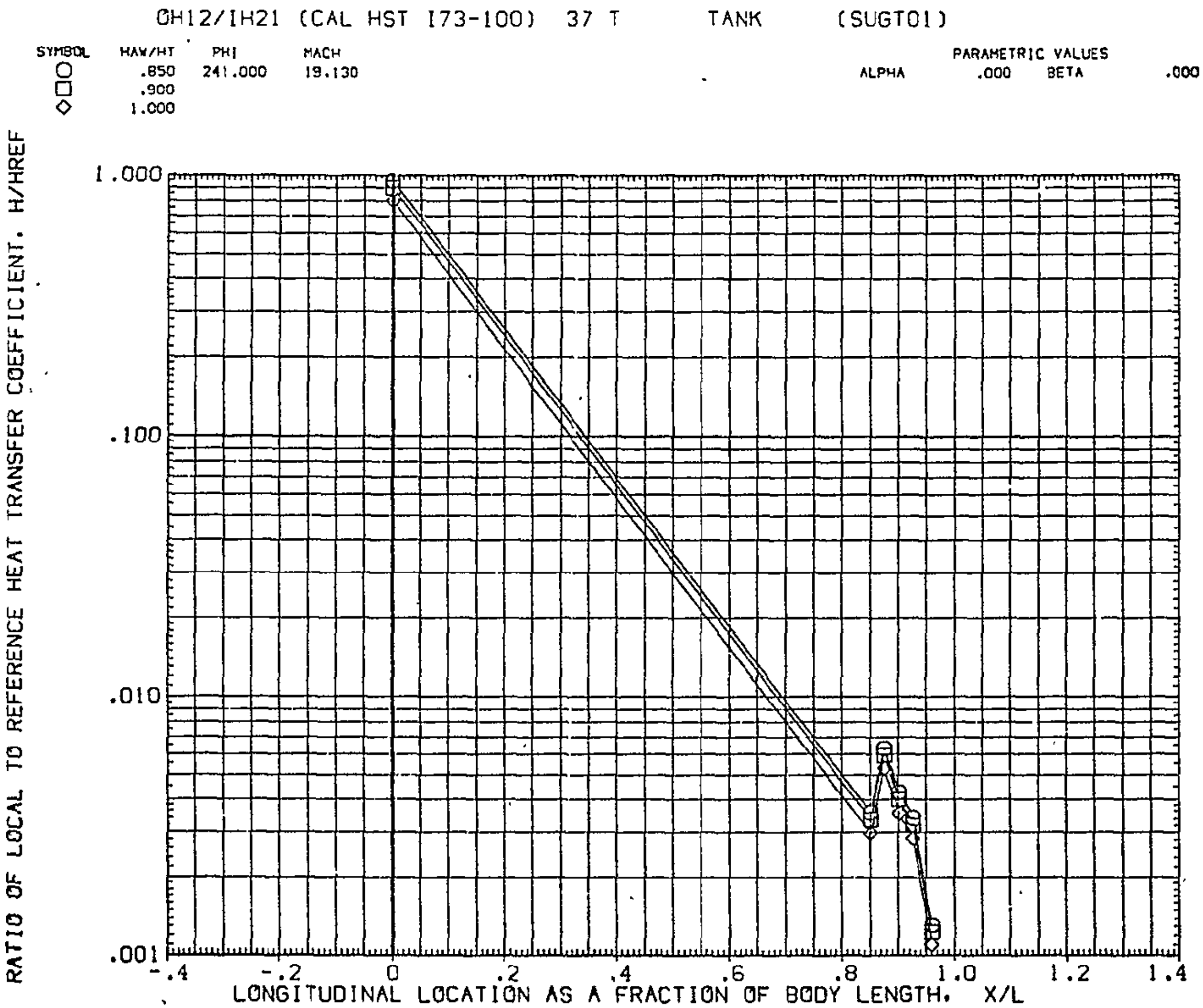


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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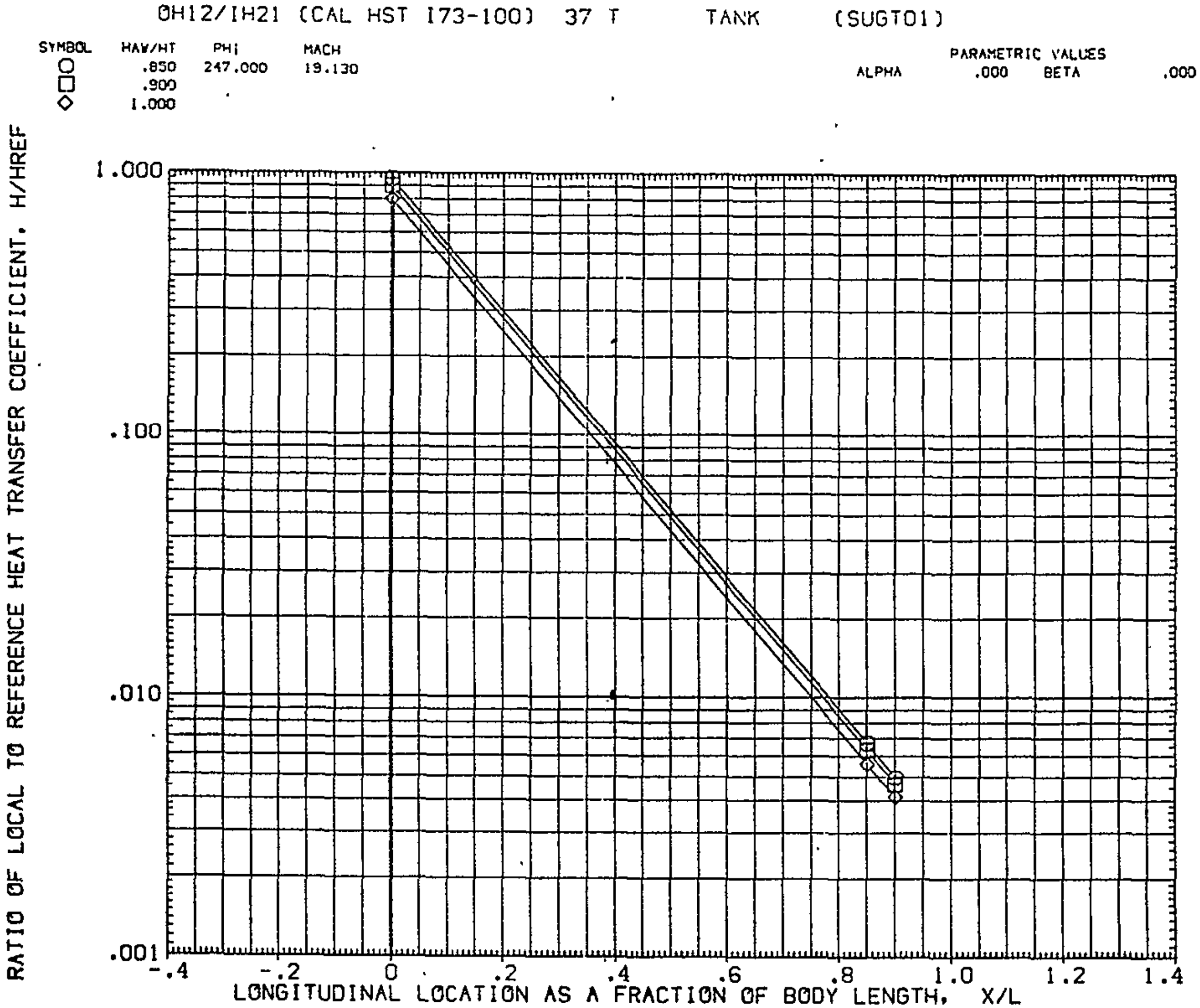

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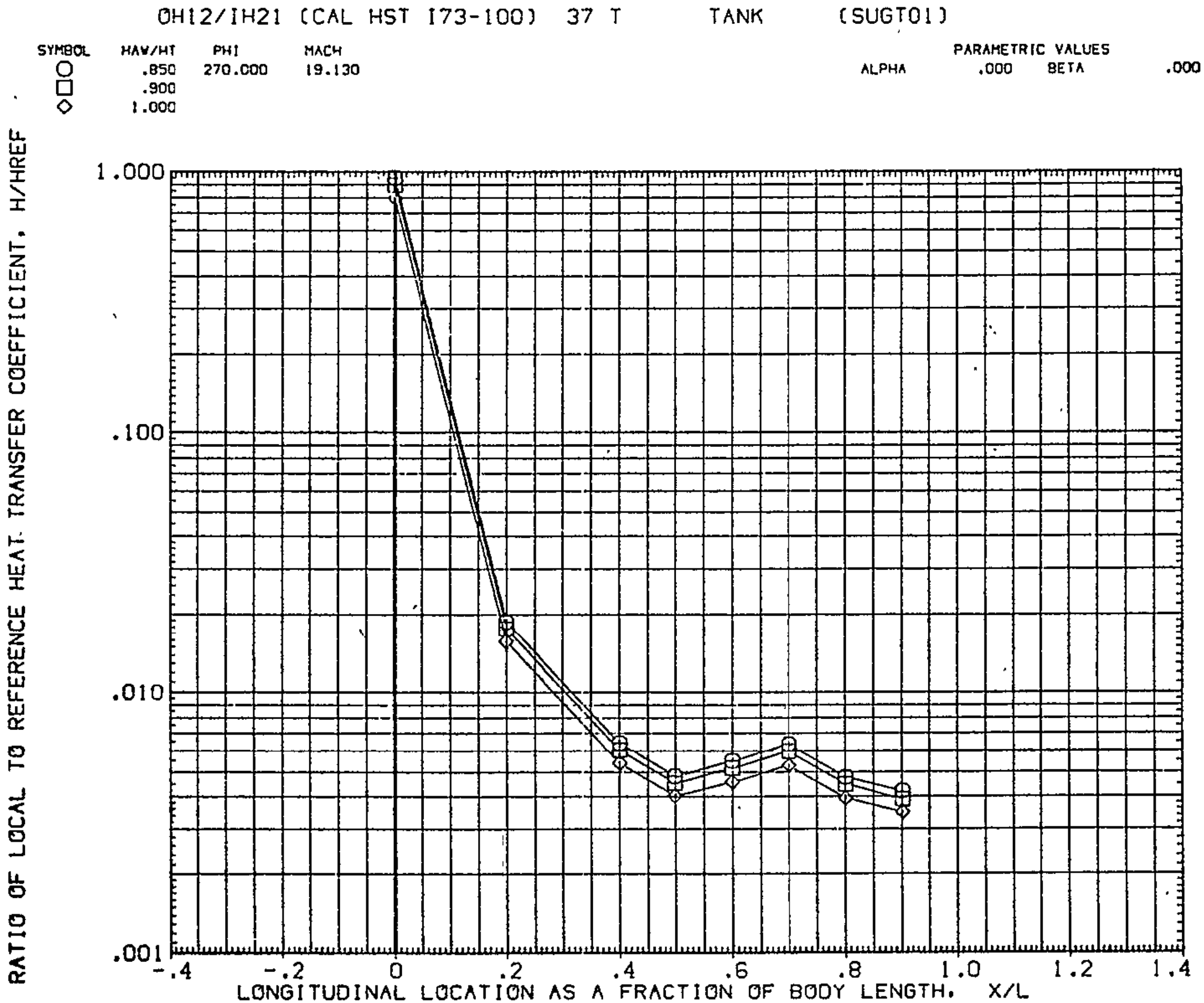

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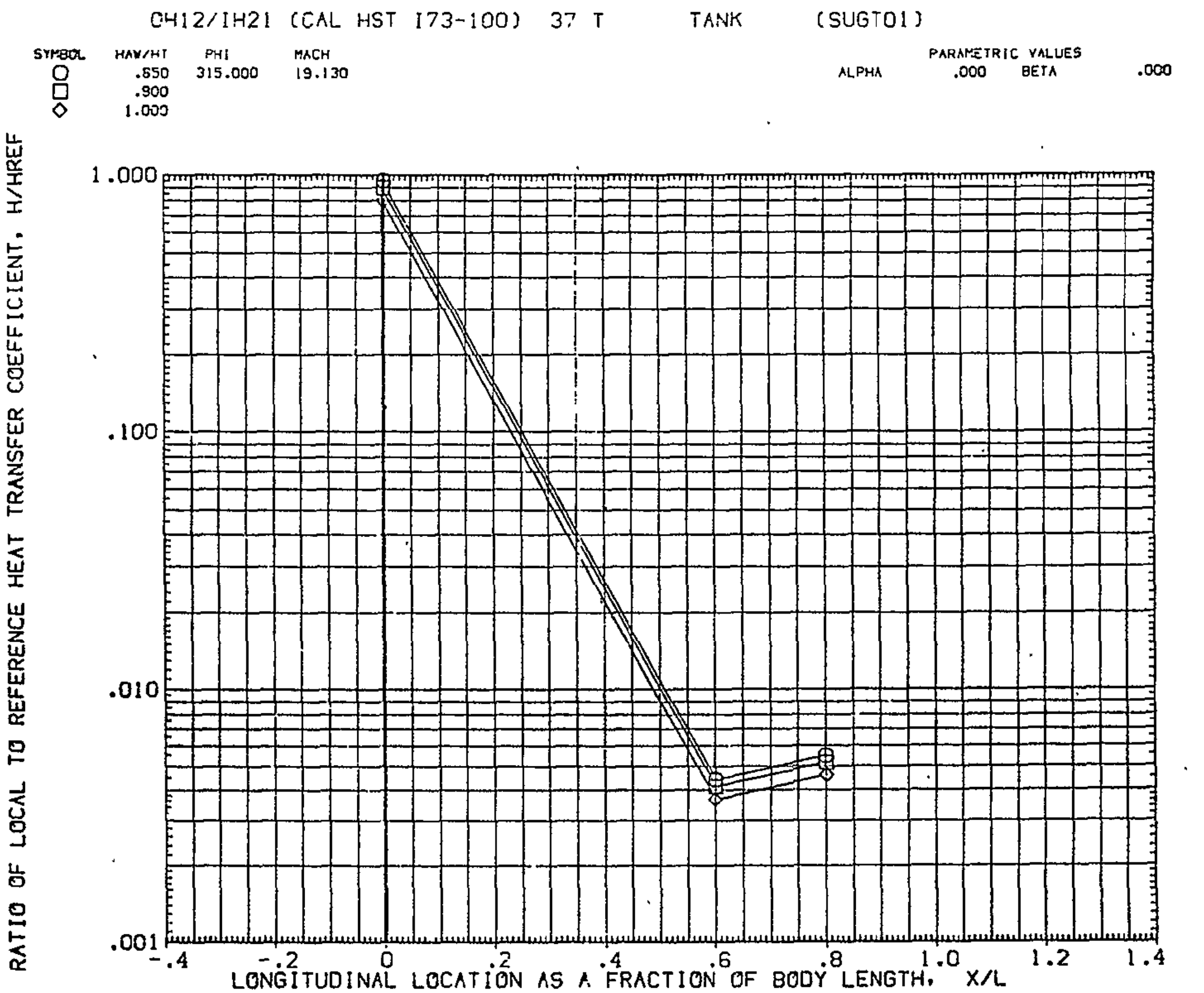
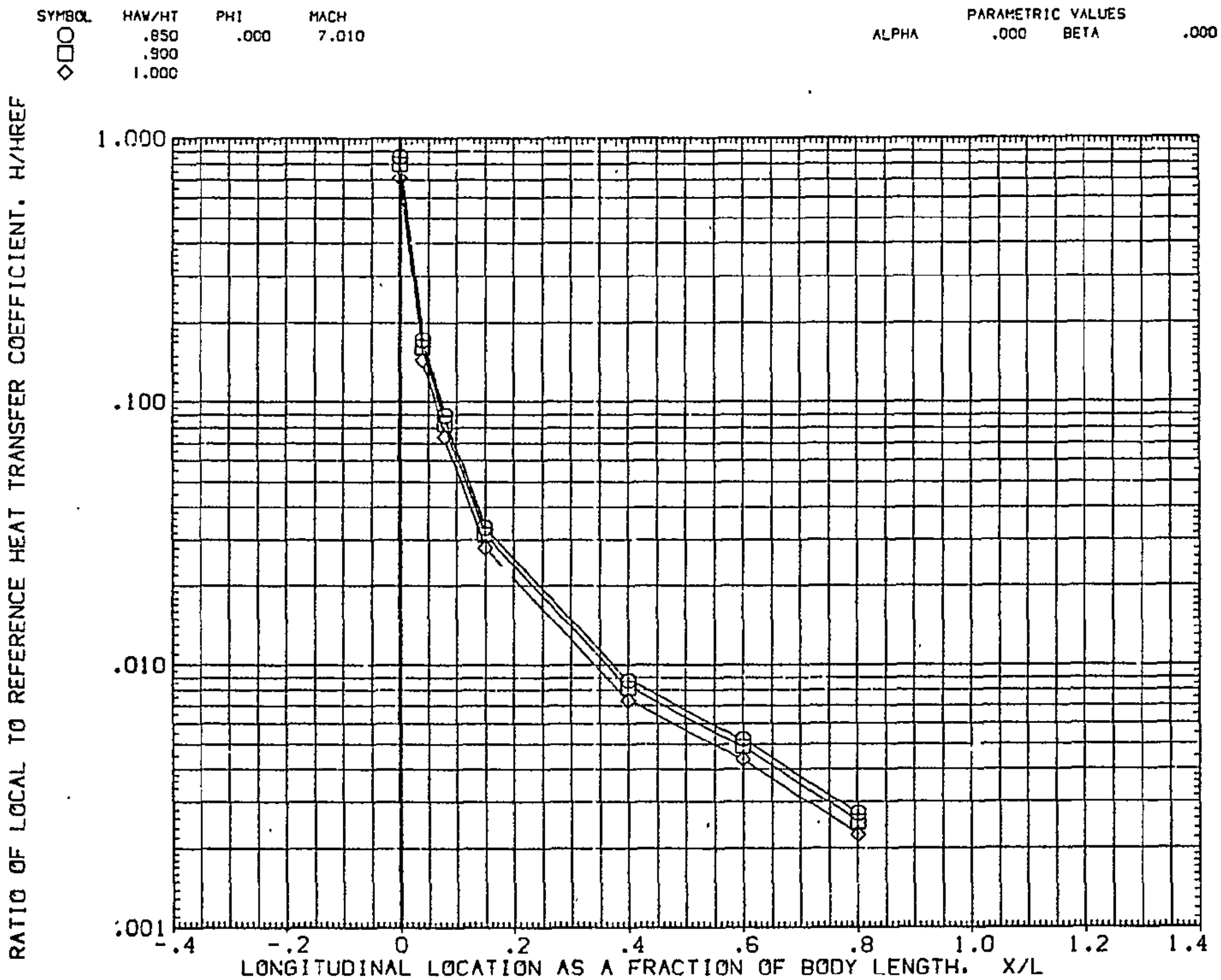


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T TANK (RUGT05)



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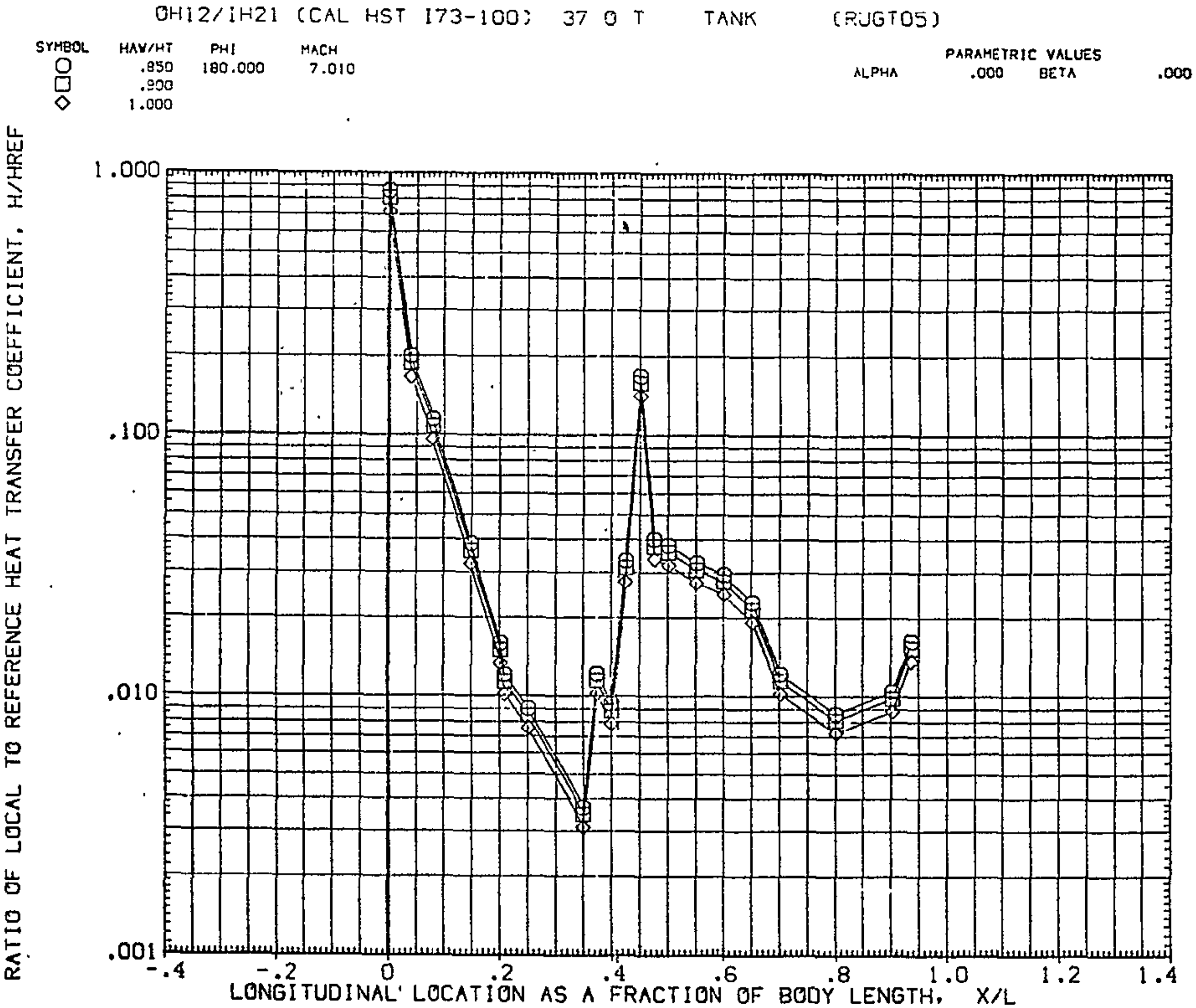

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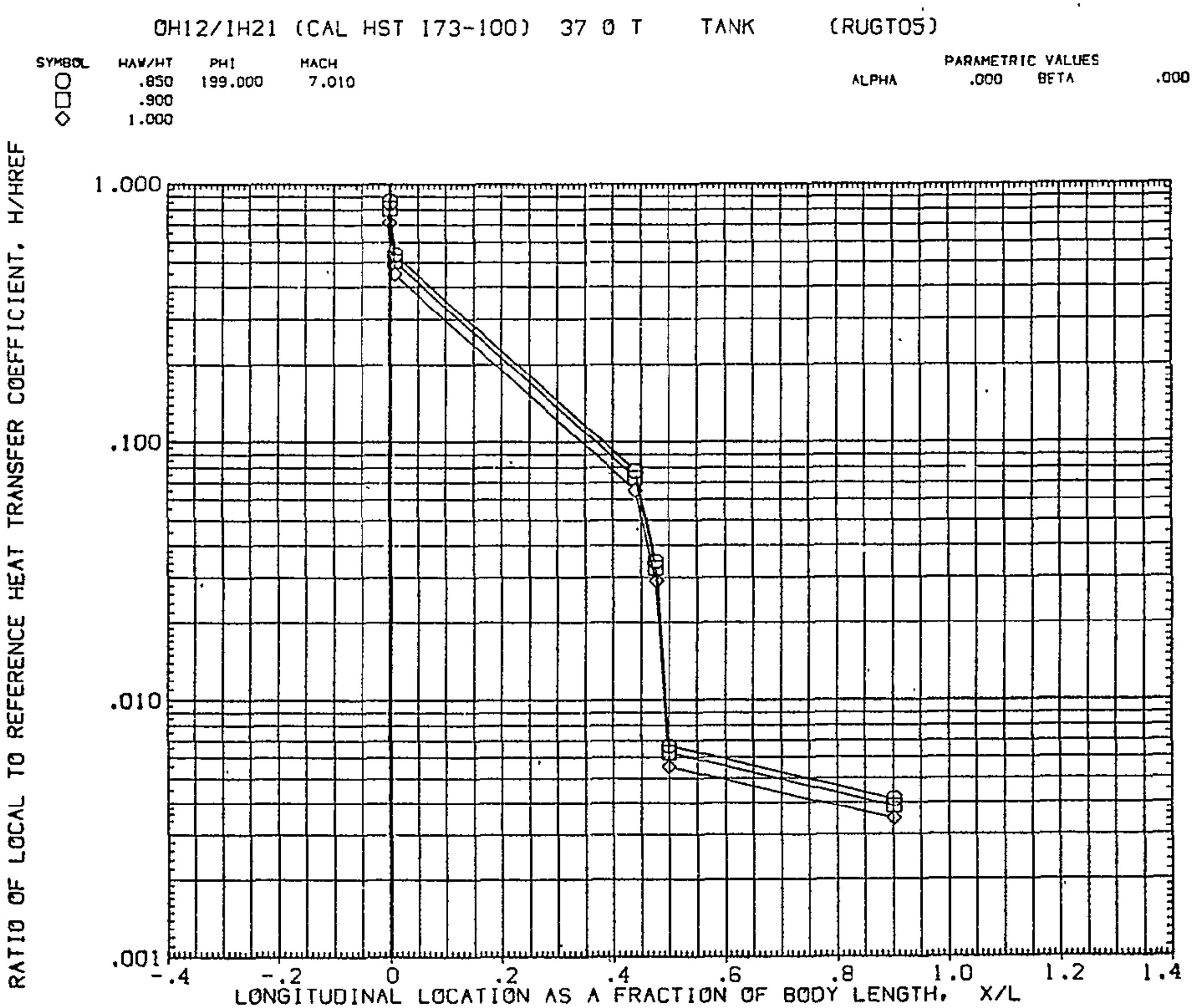


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

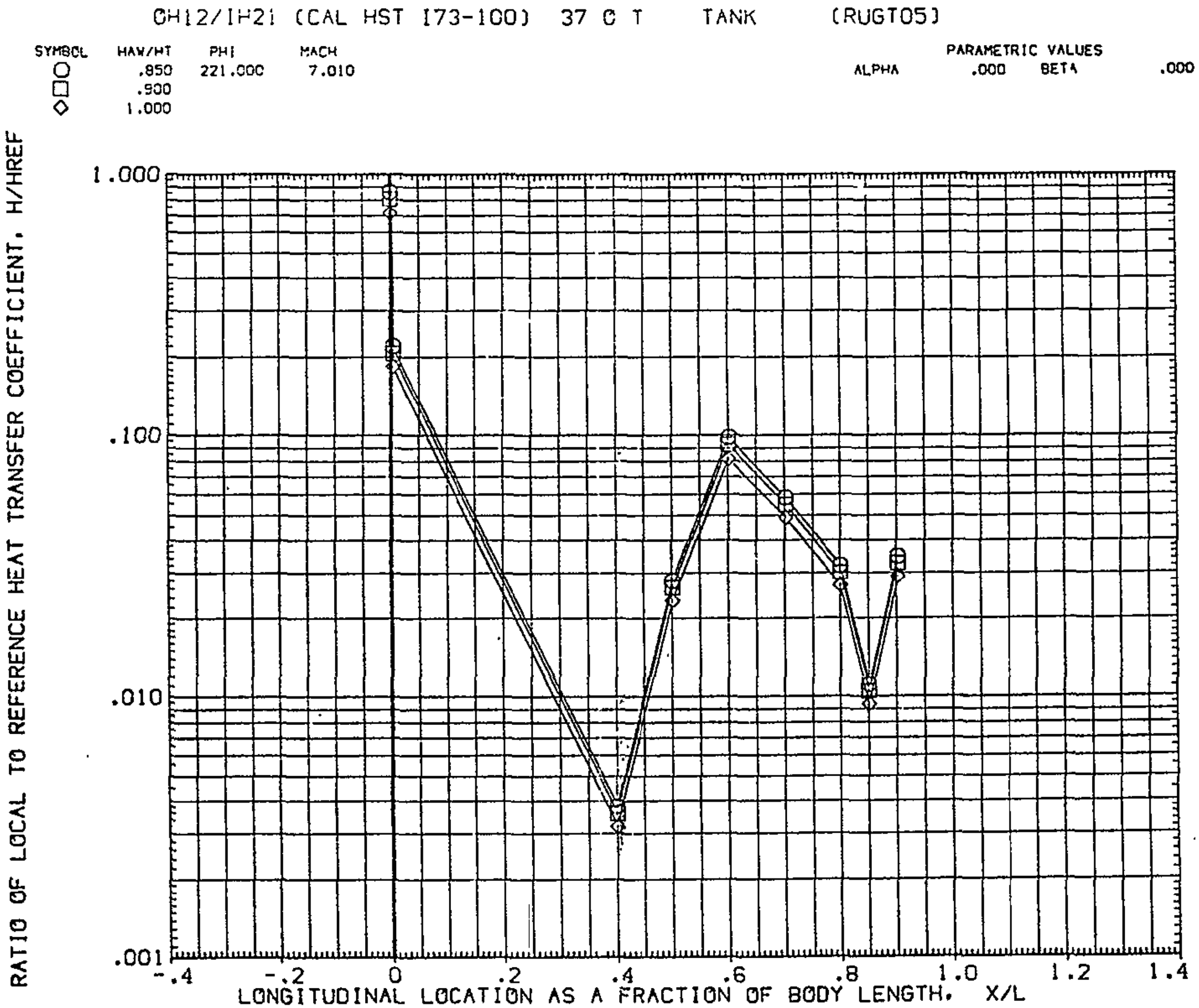


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

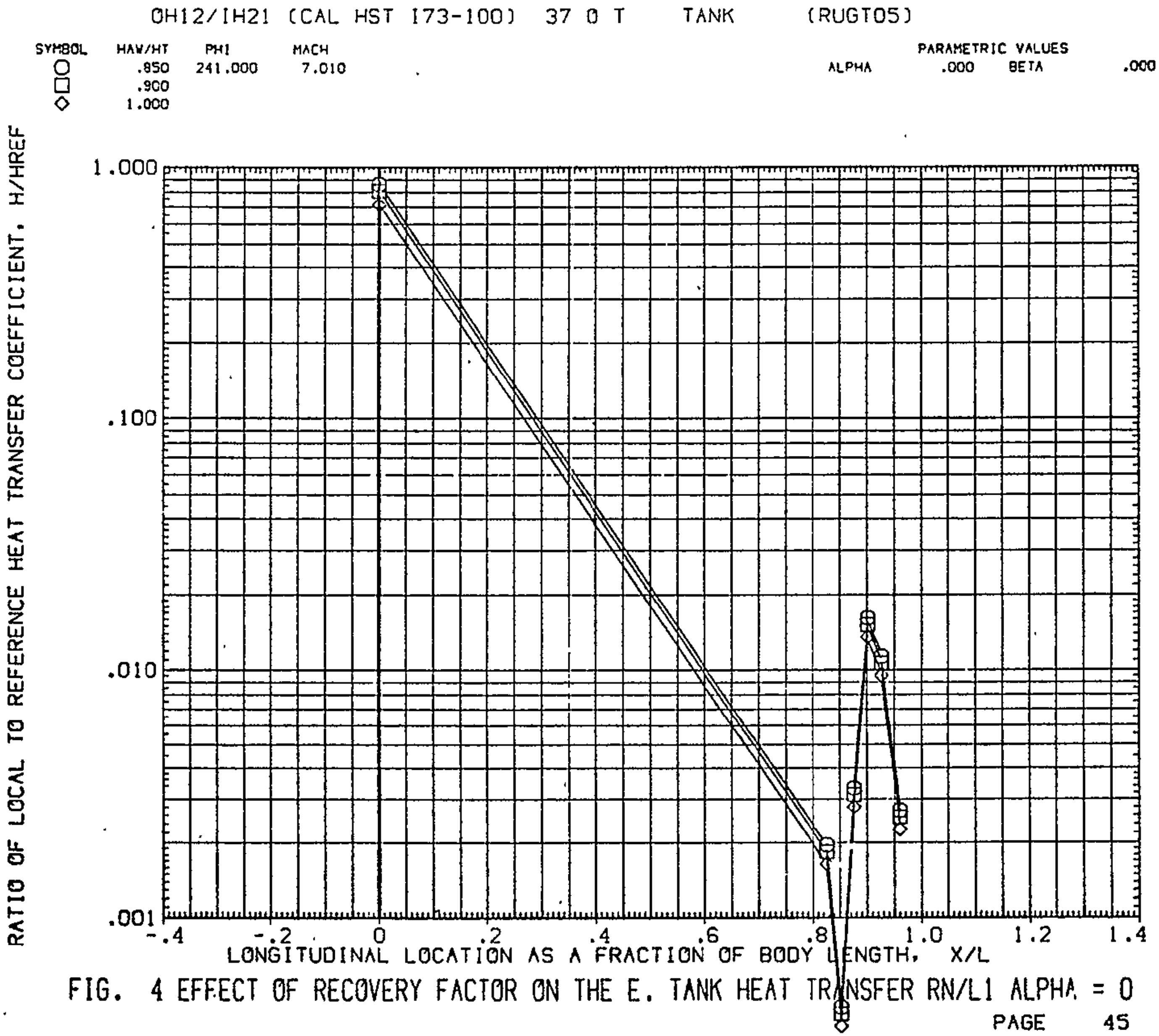


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

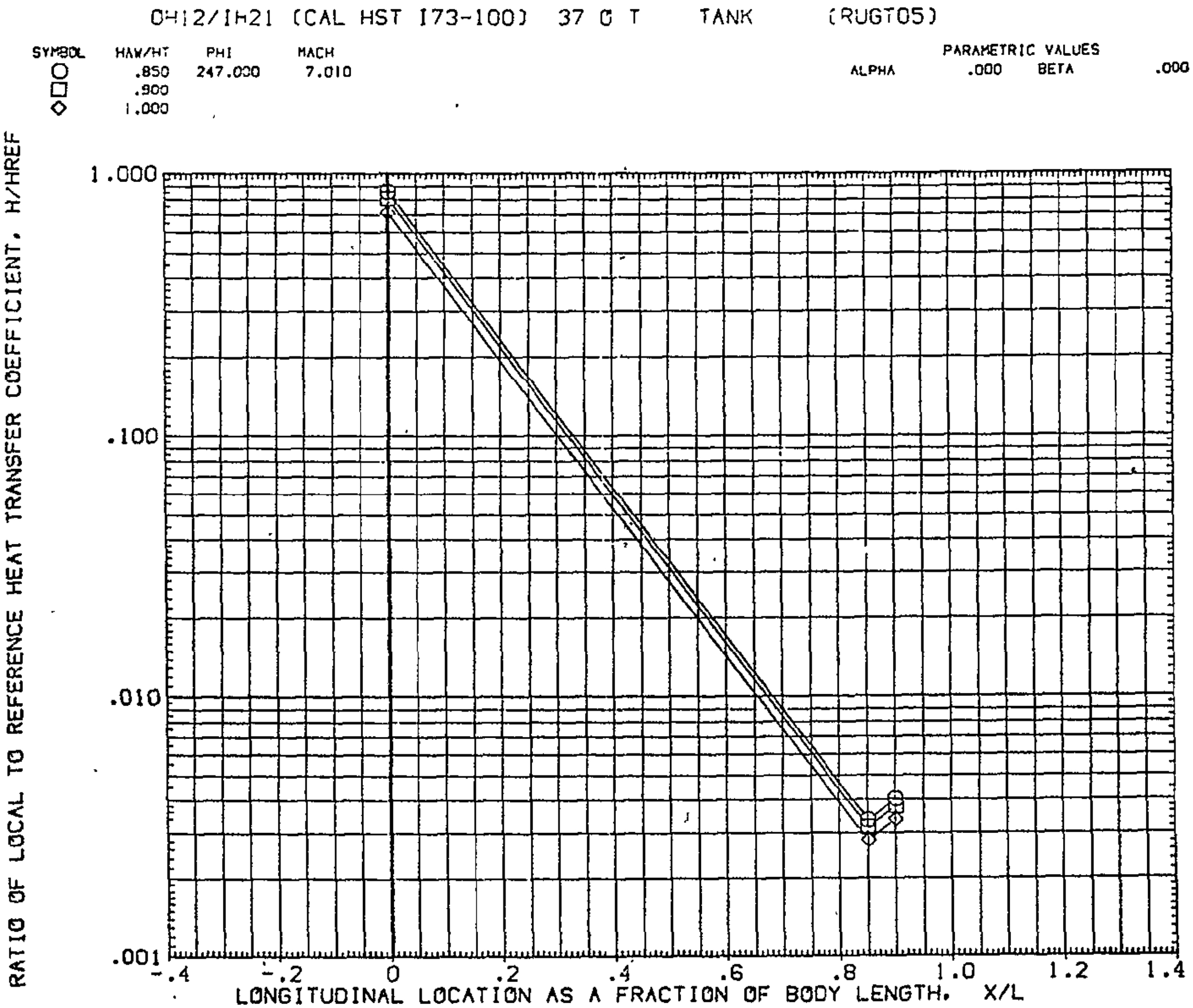
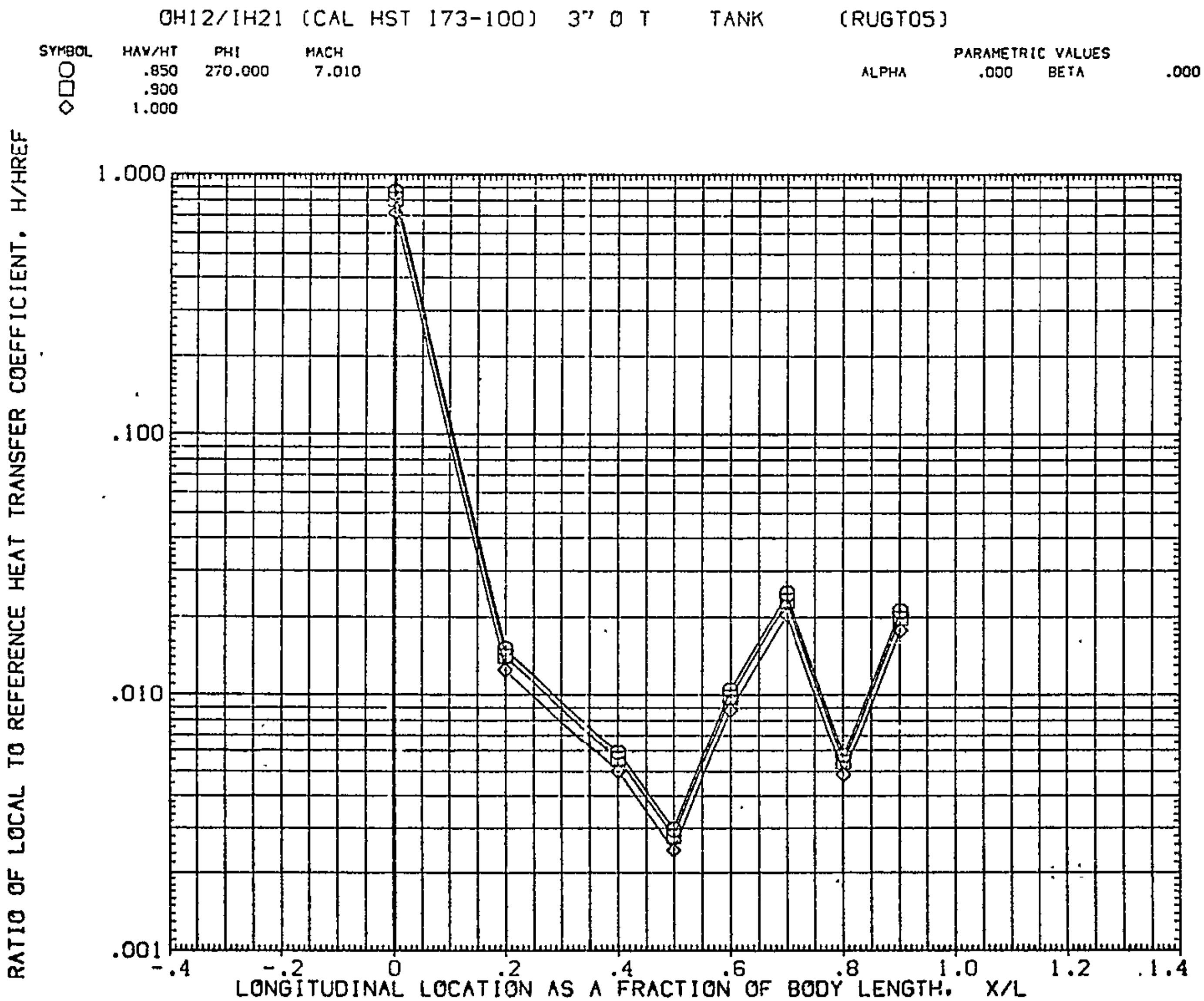


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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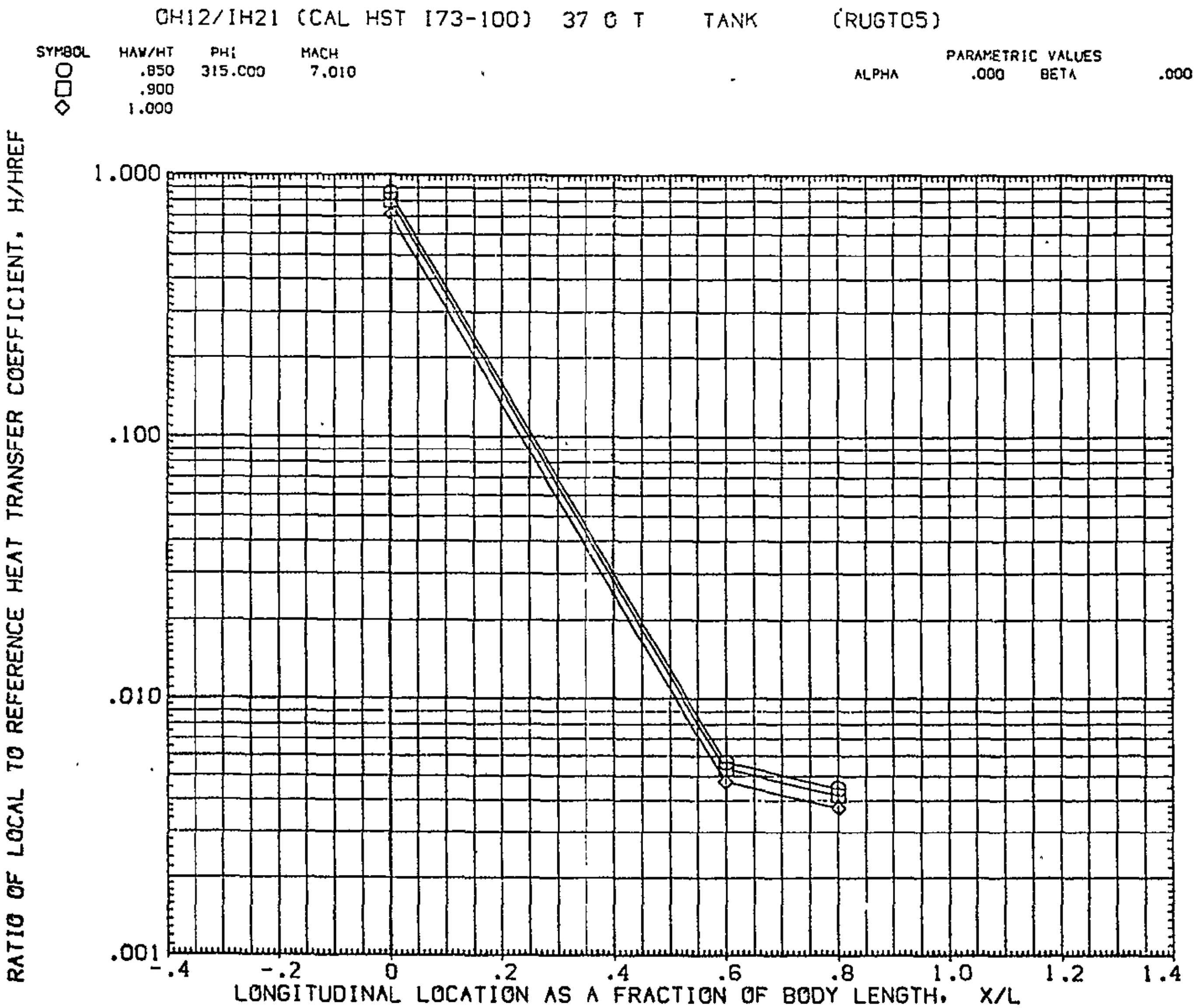


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

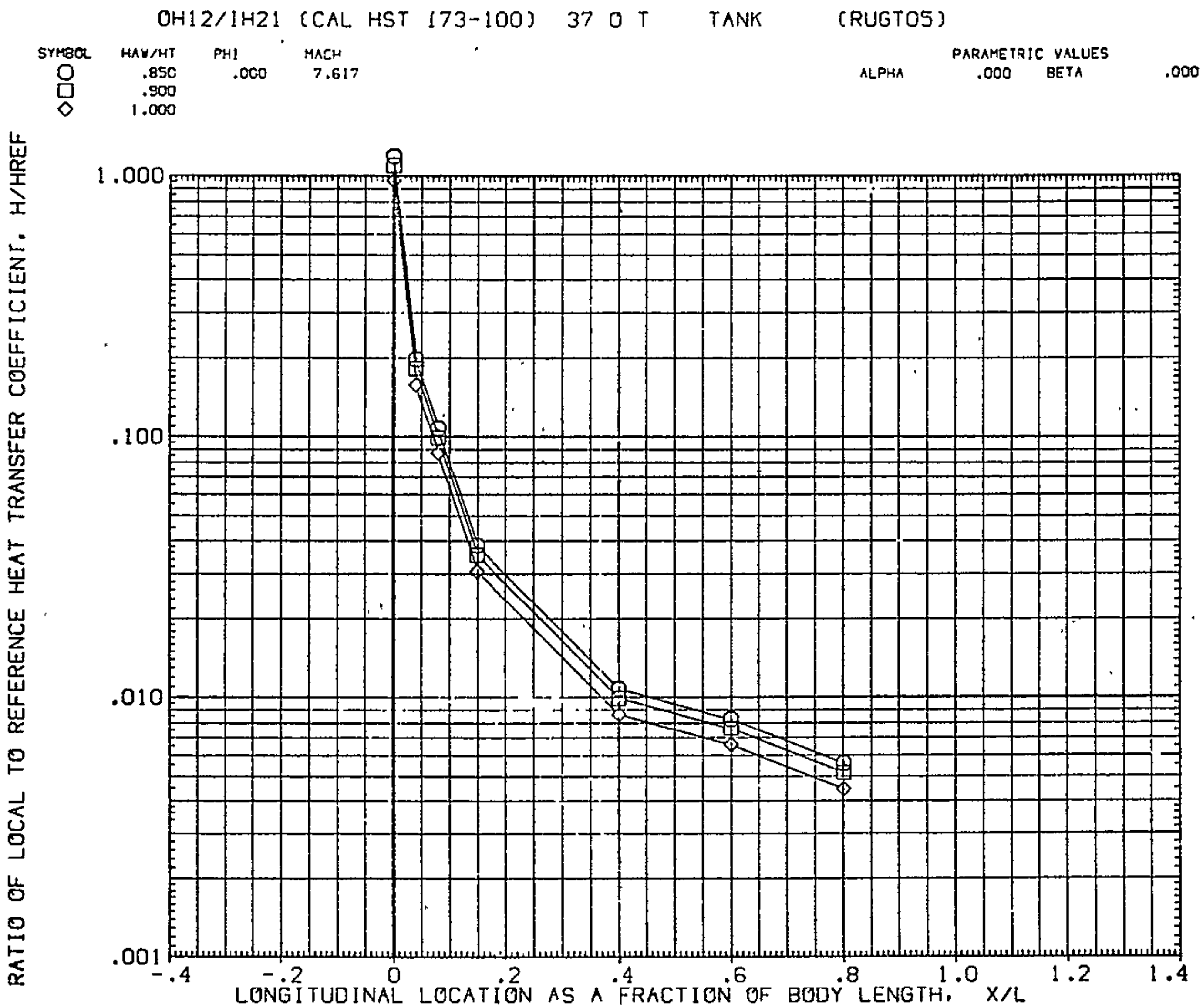
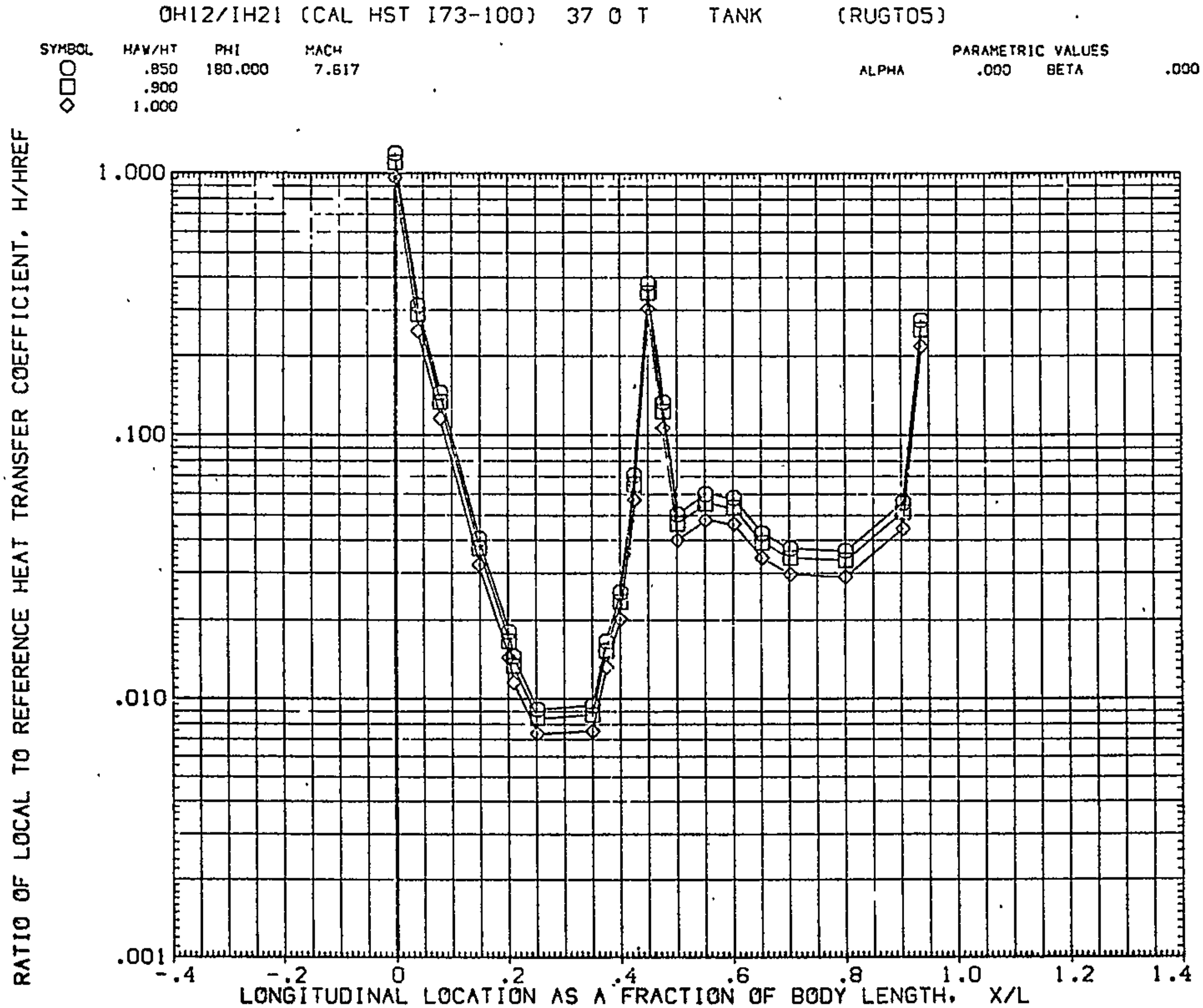


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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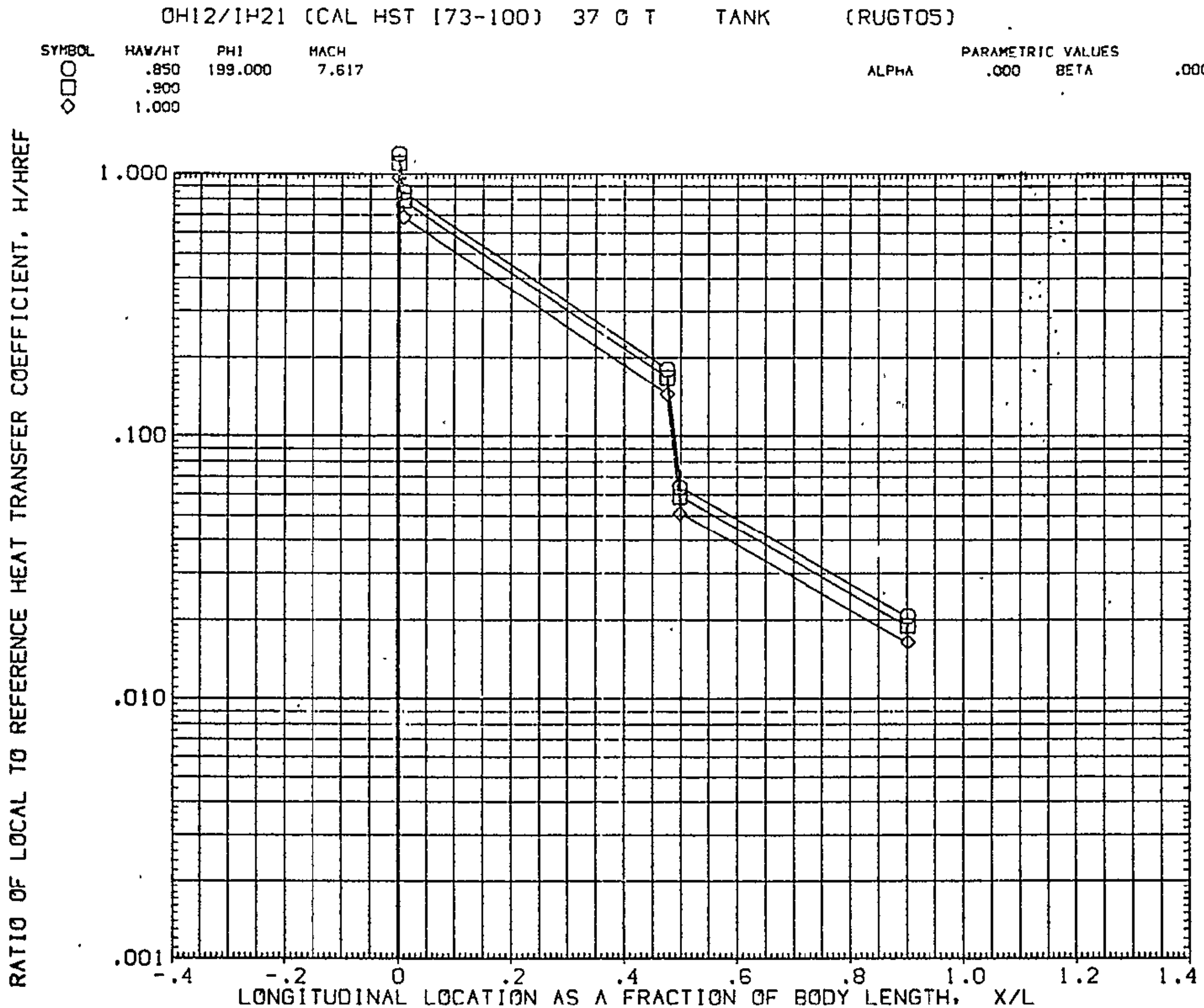


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T TANK (RUGT05)

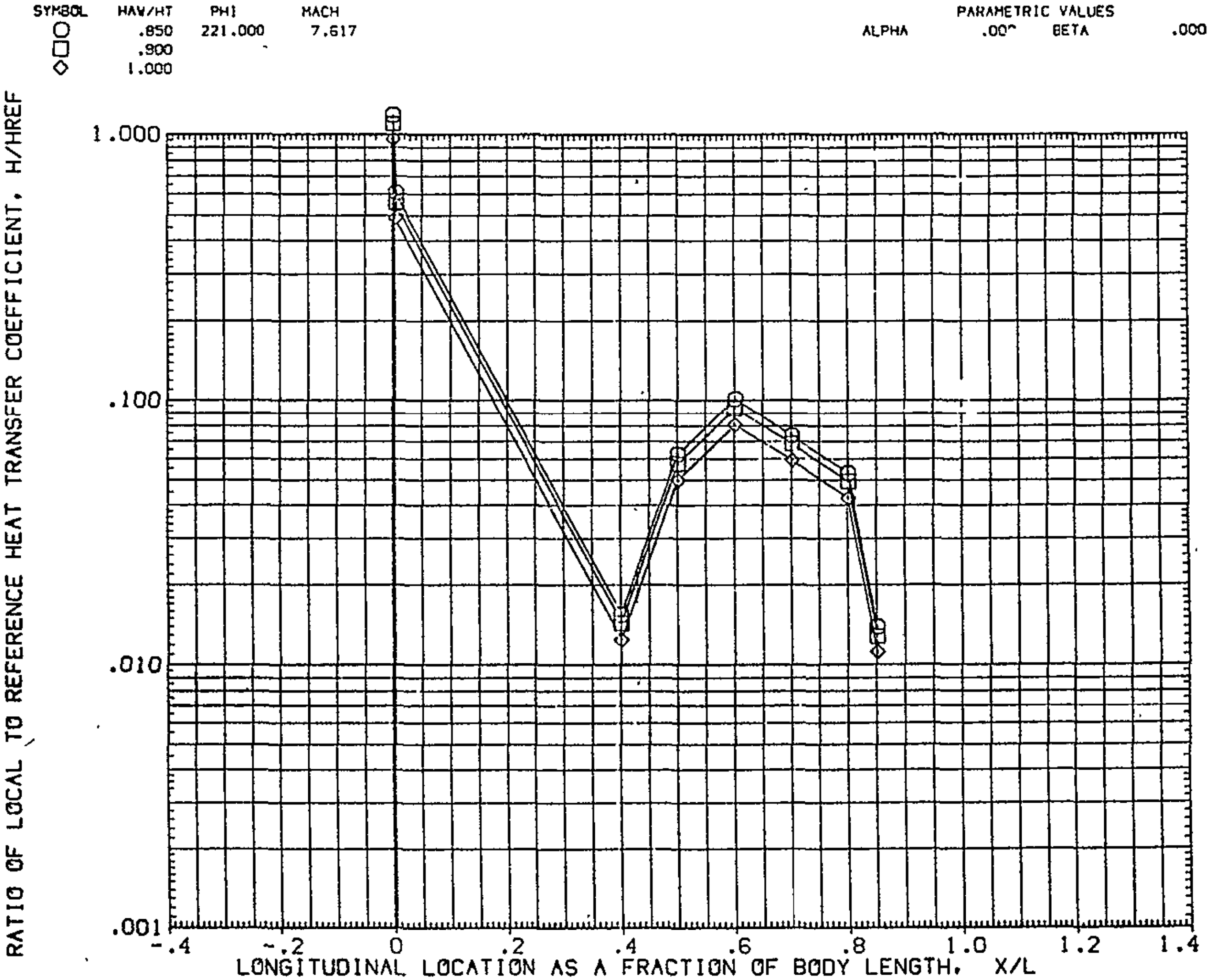
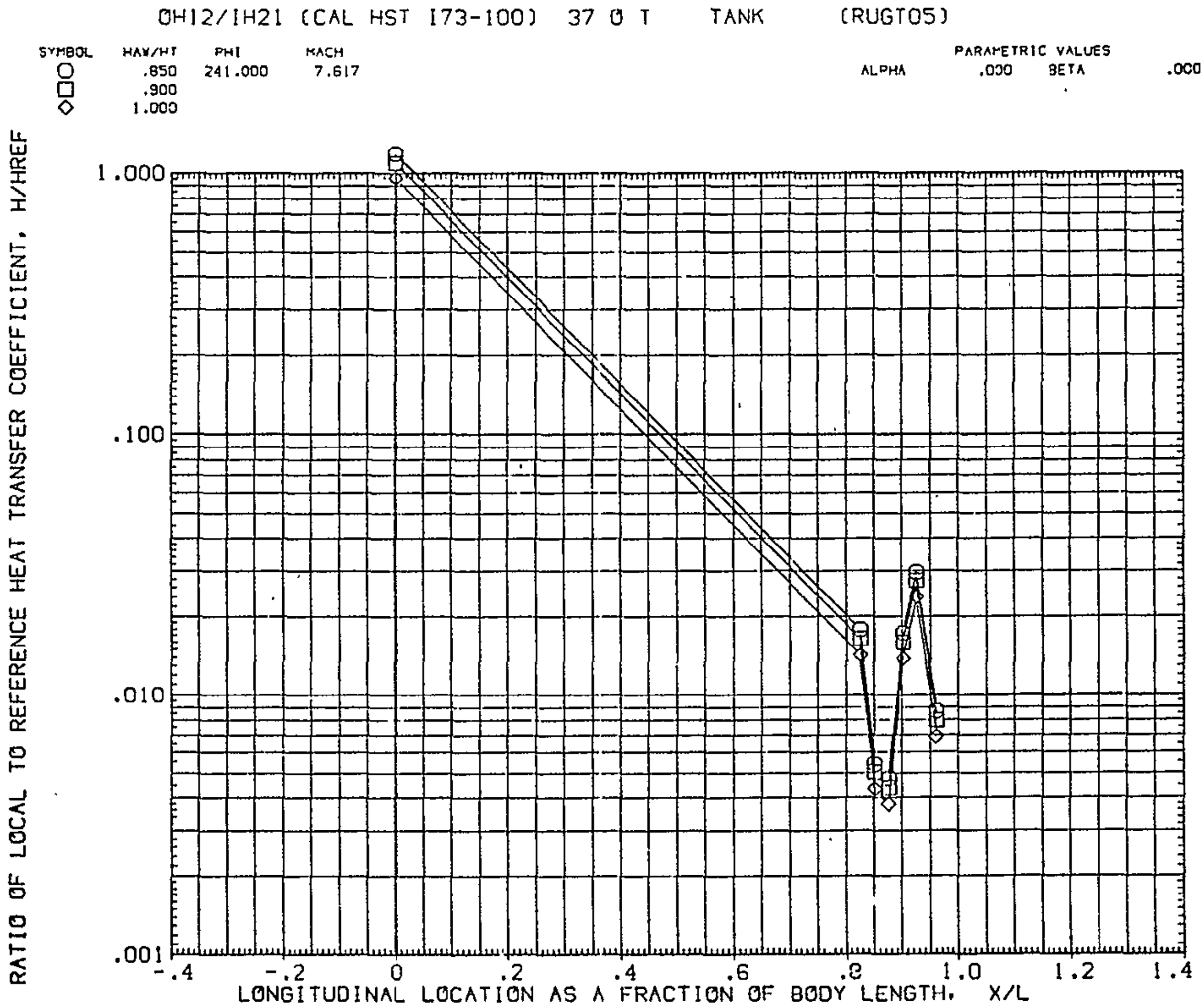


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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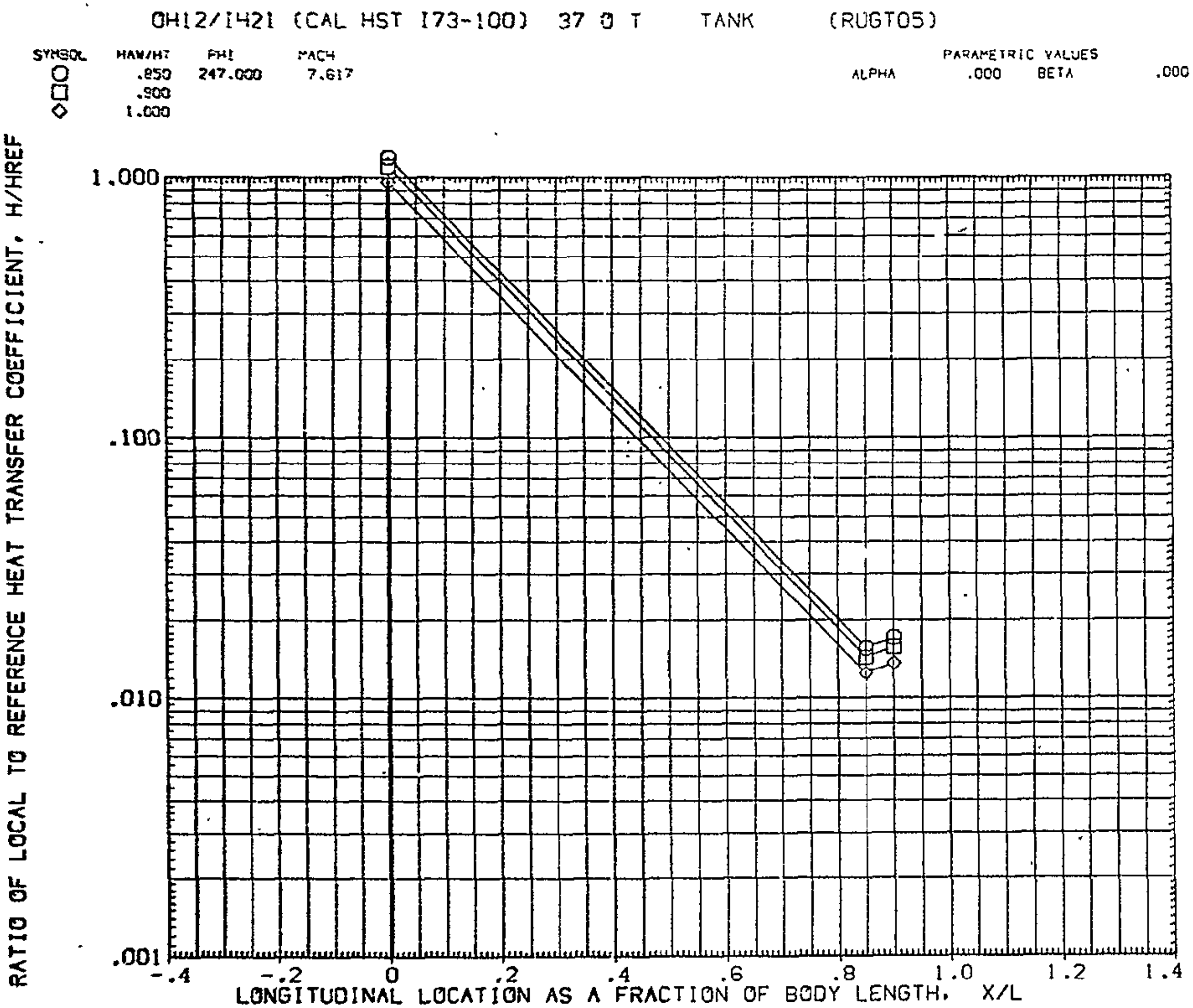
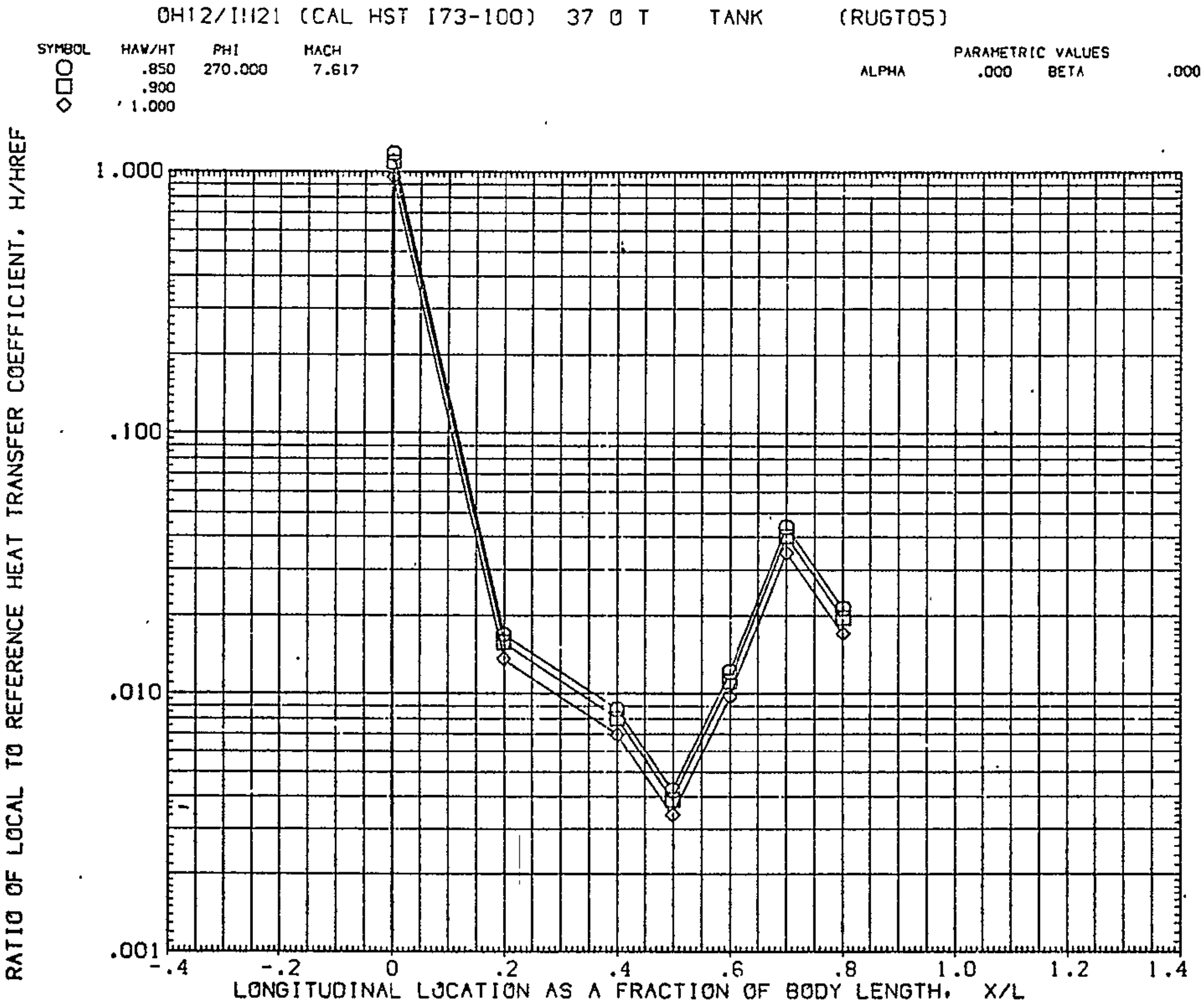


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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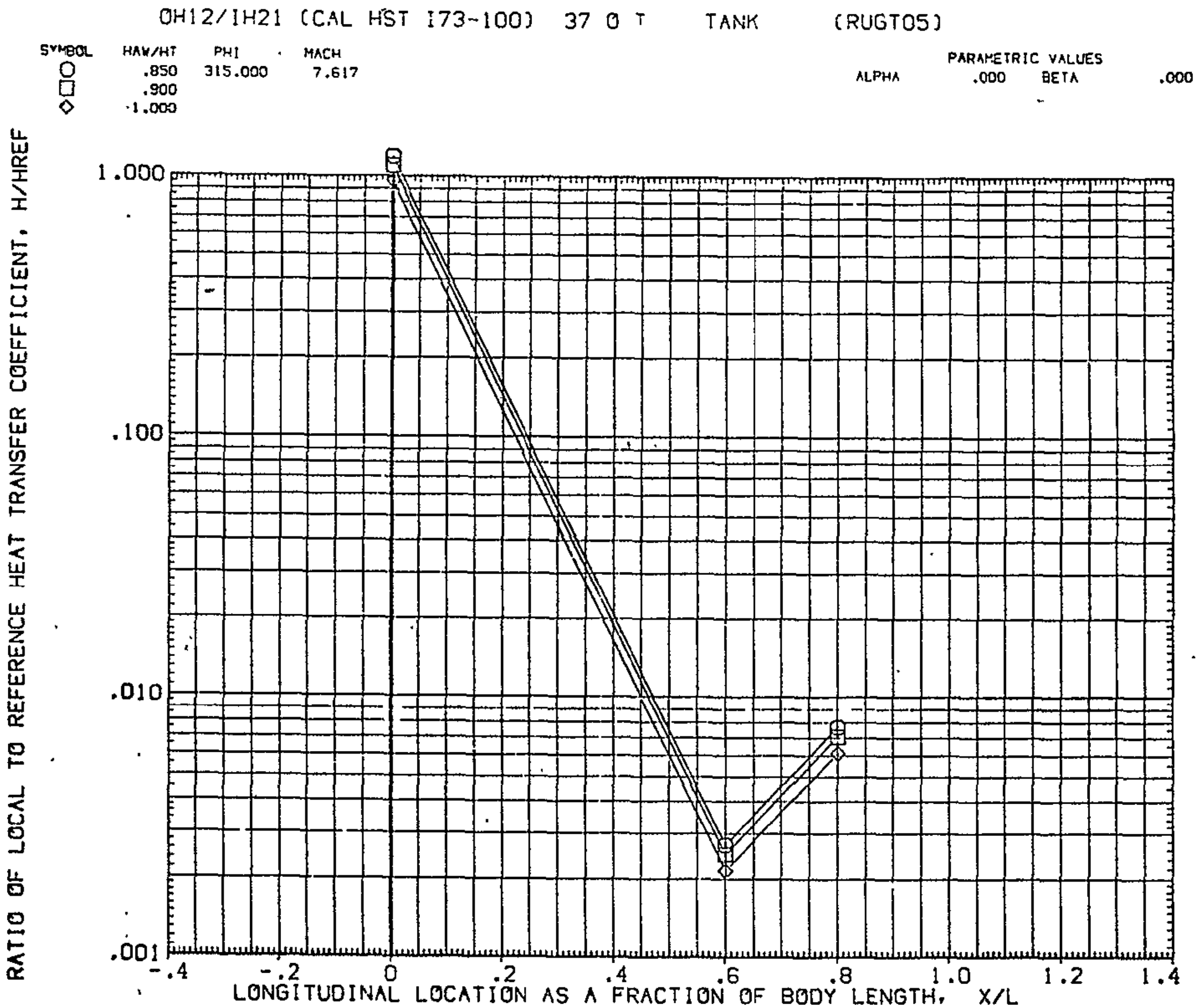

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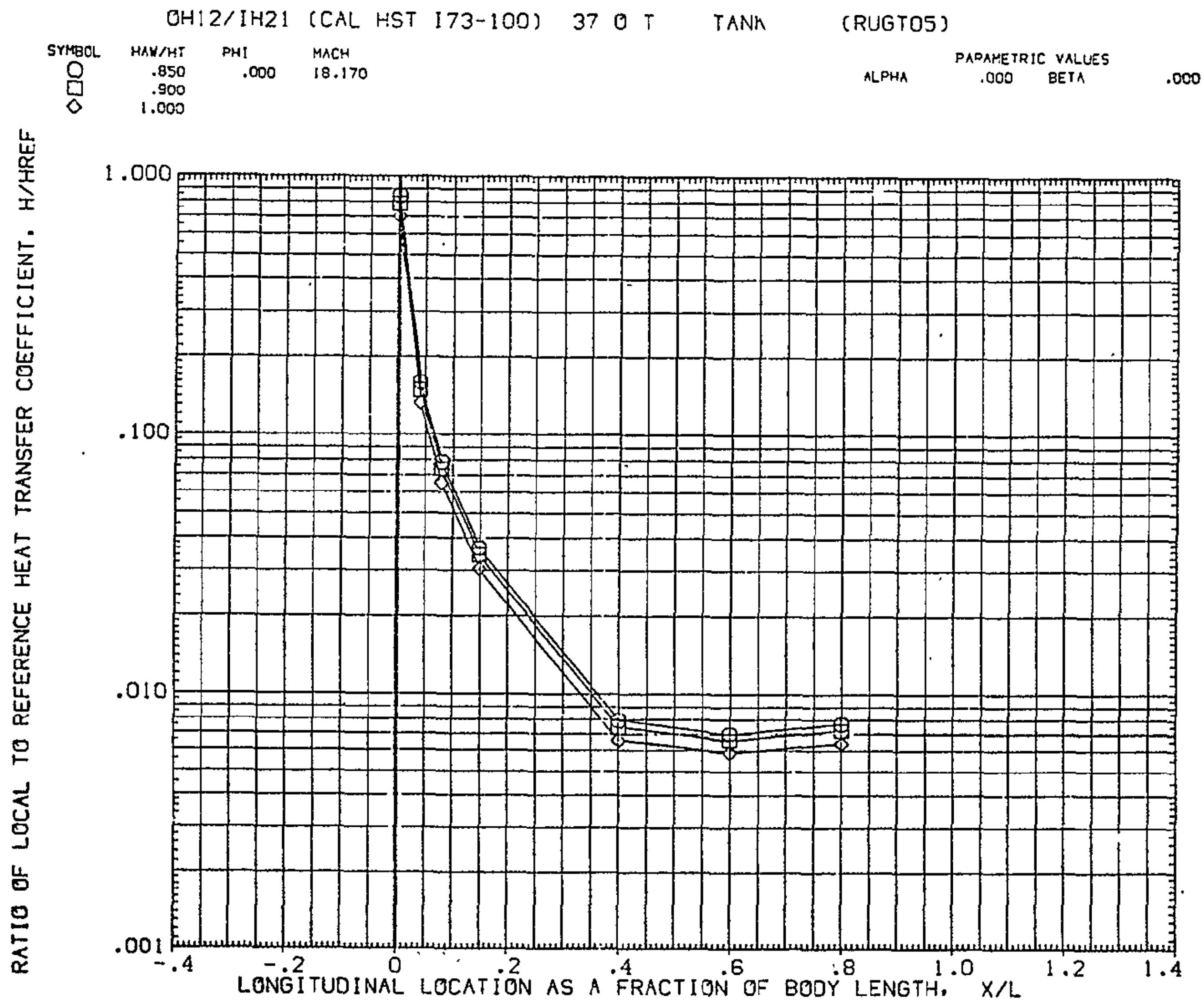

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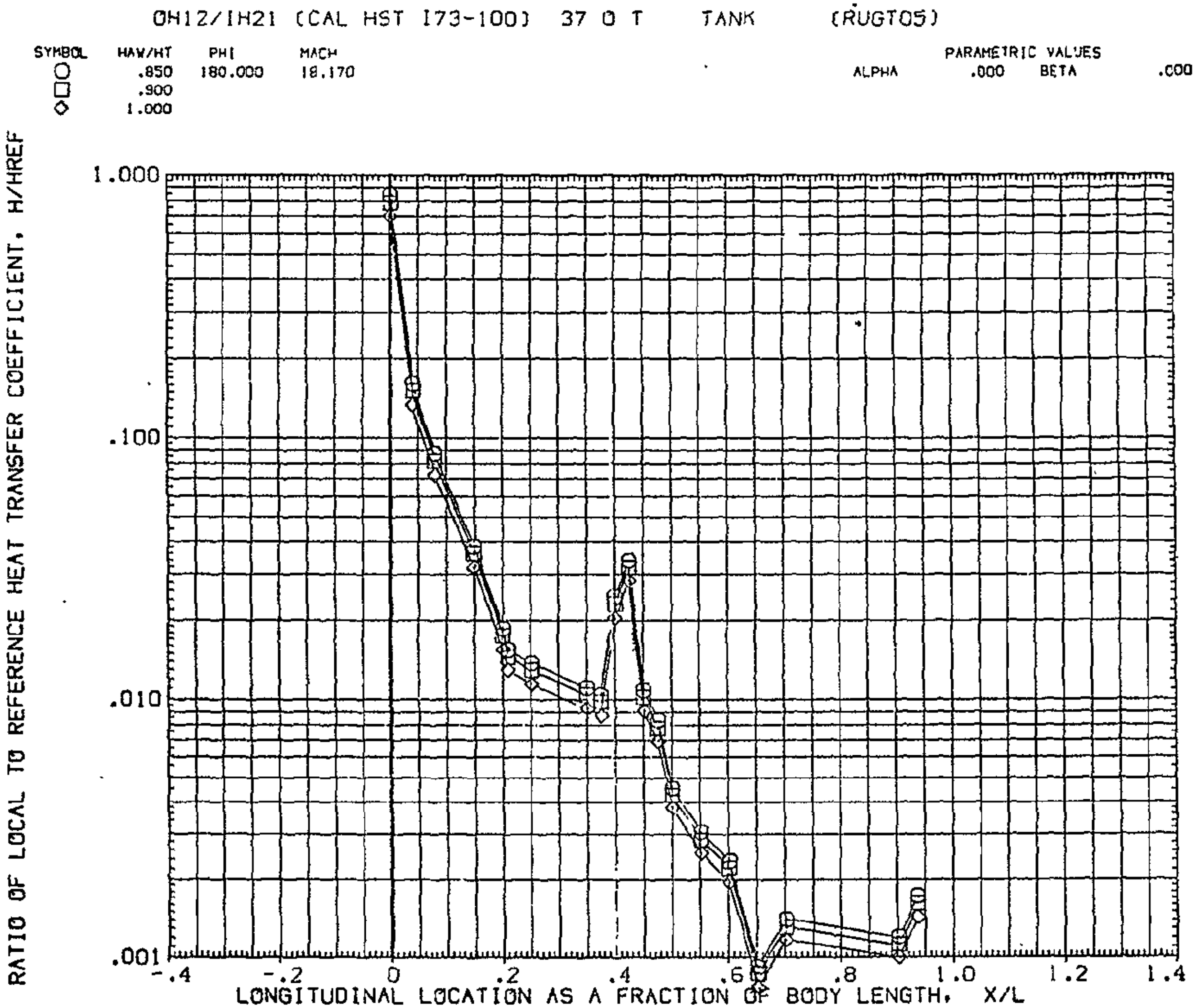
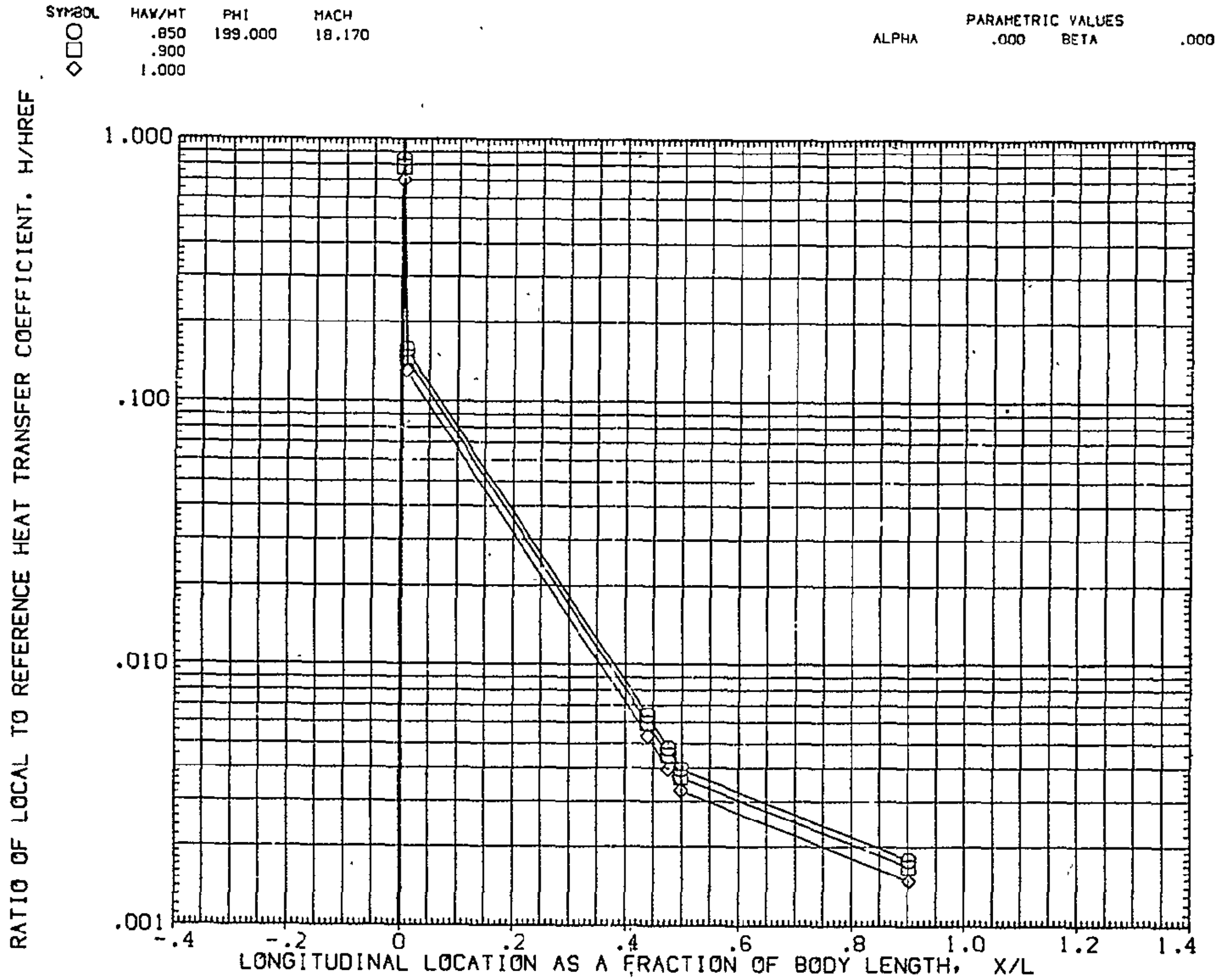


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T TANK (RUGT05)



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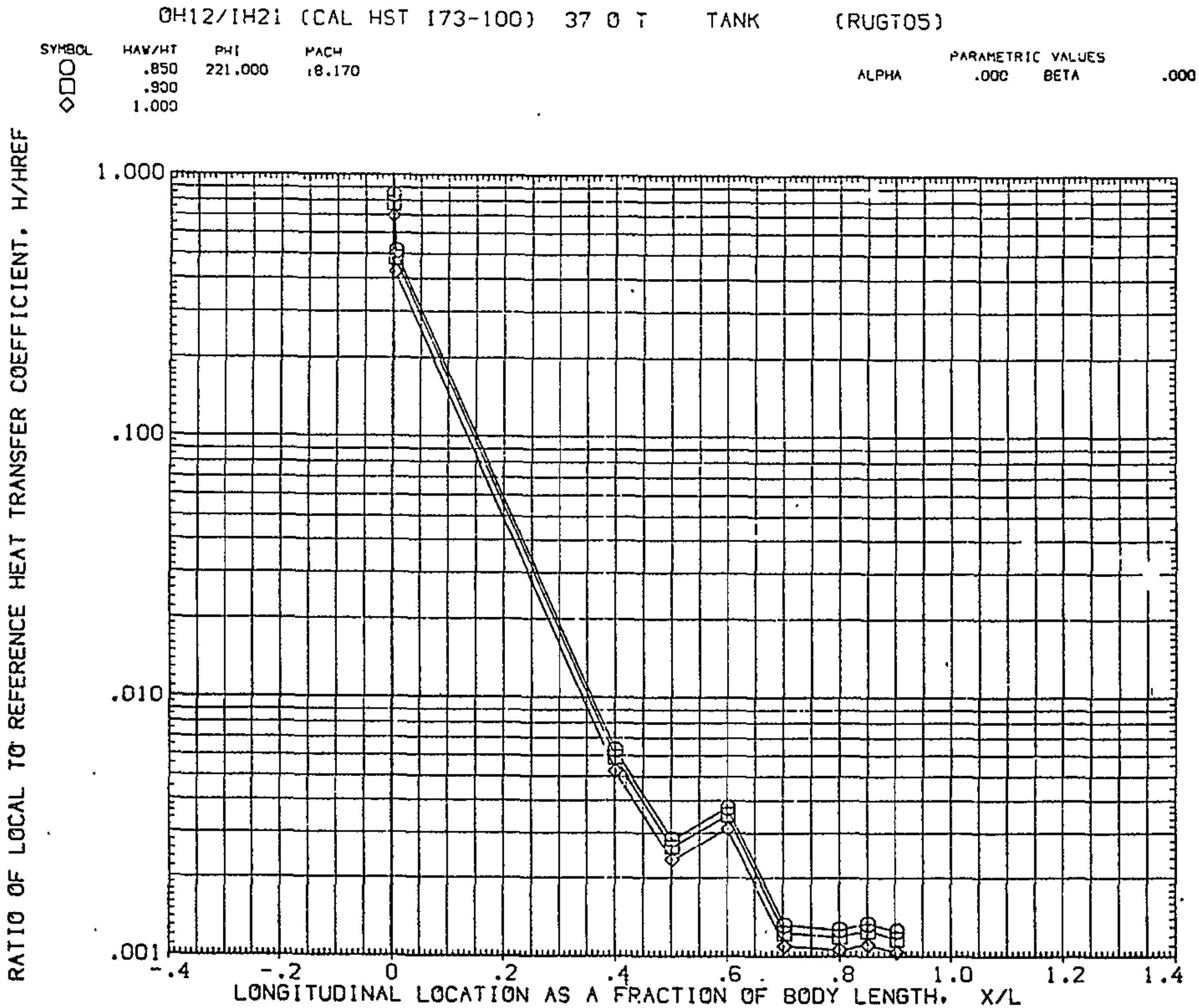
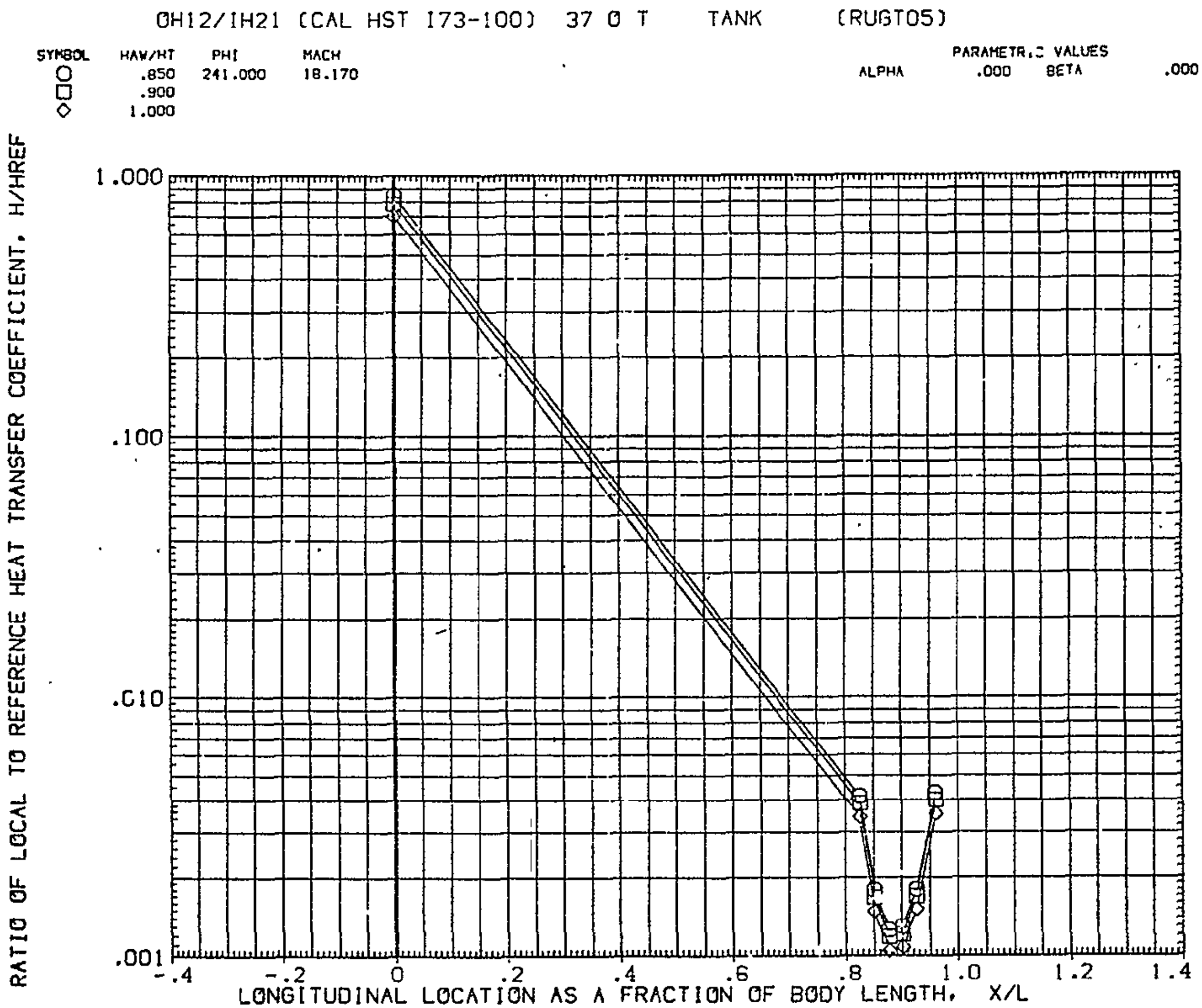


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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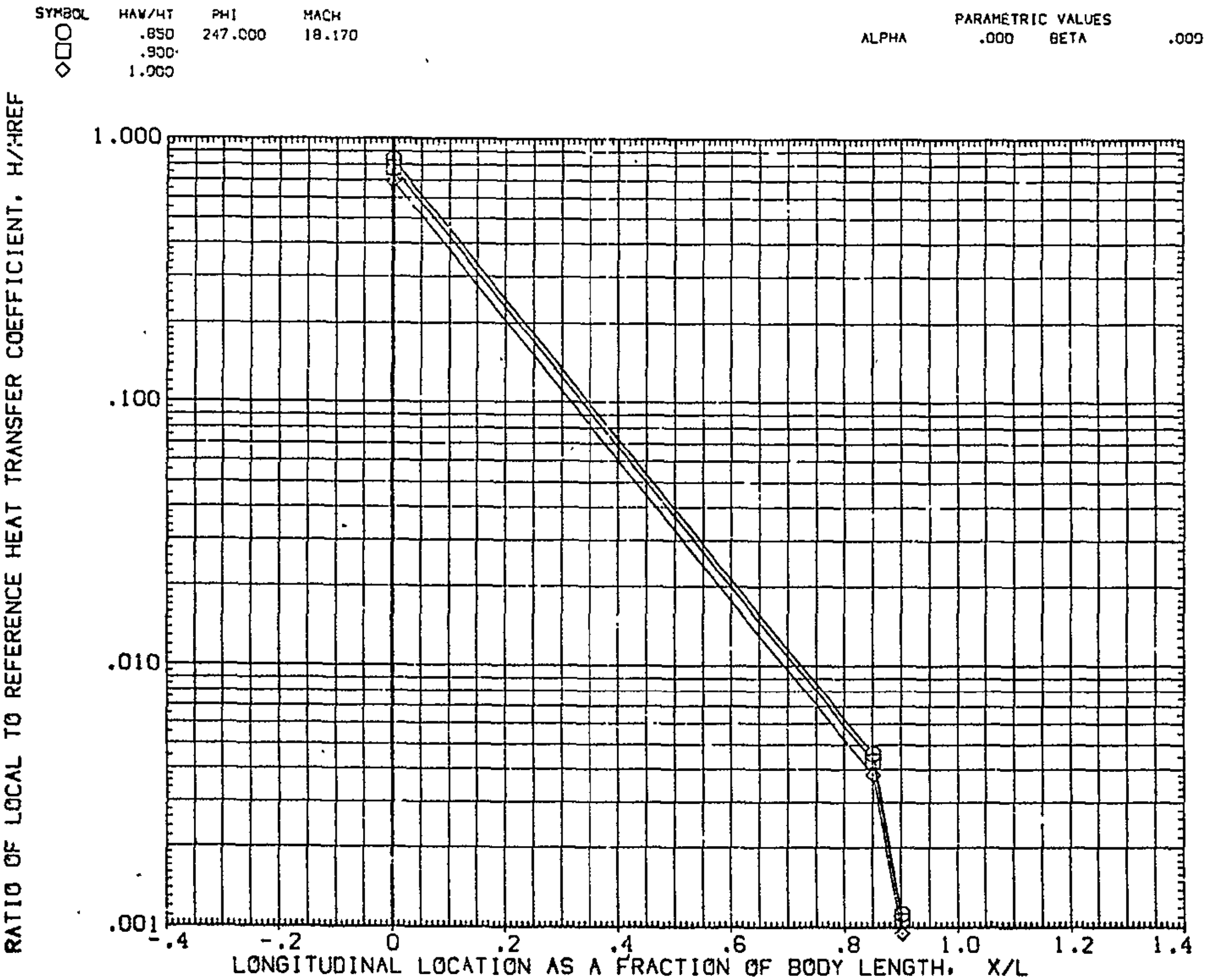
OH12/IH21 (CAL HST I73-100) 37 0 T TANK (RUGT05)



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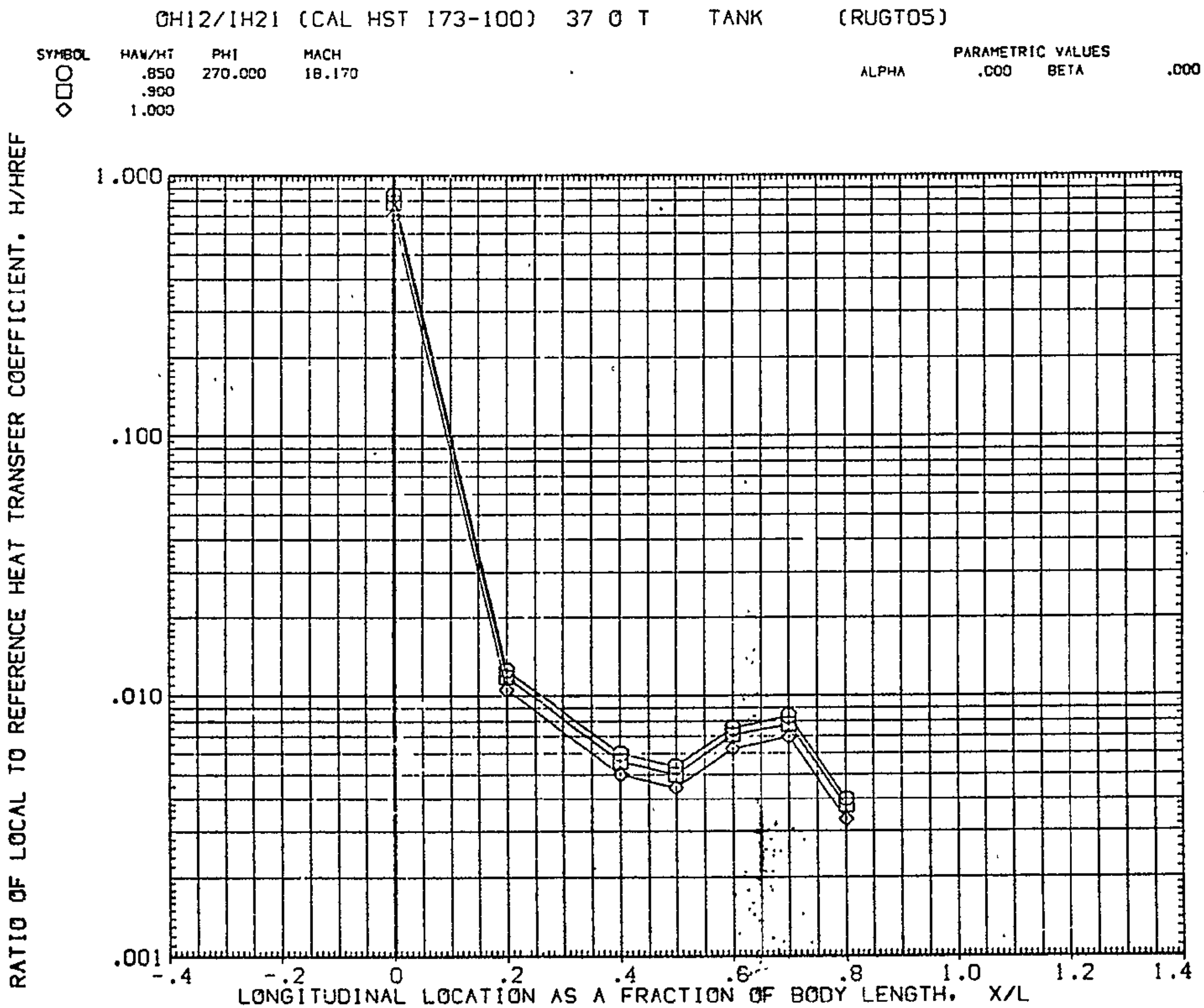
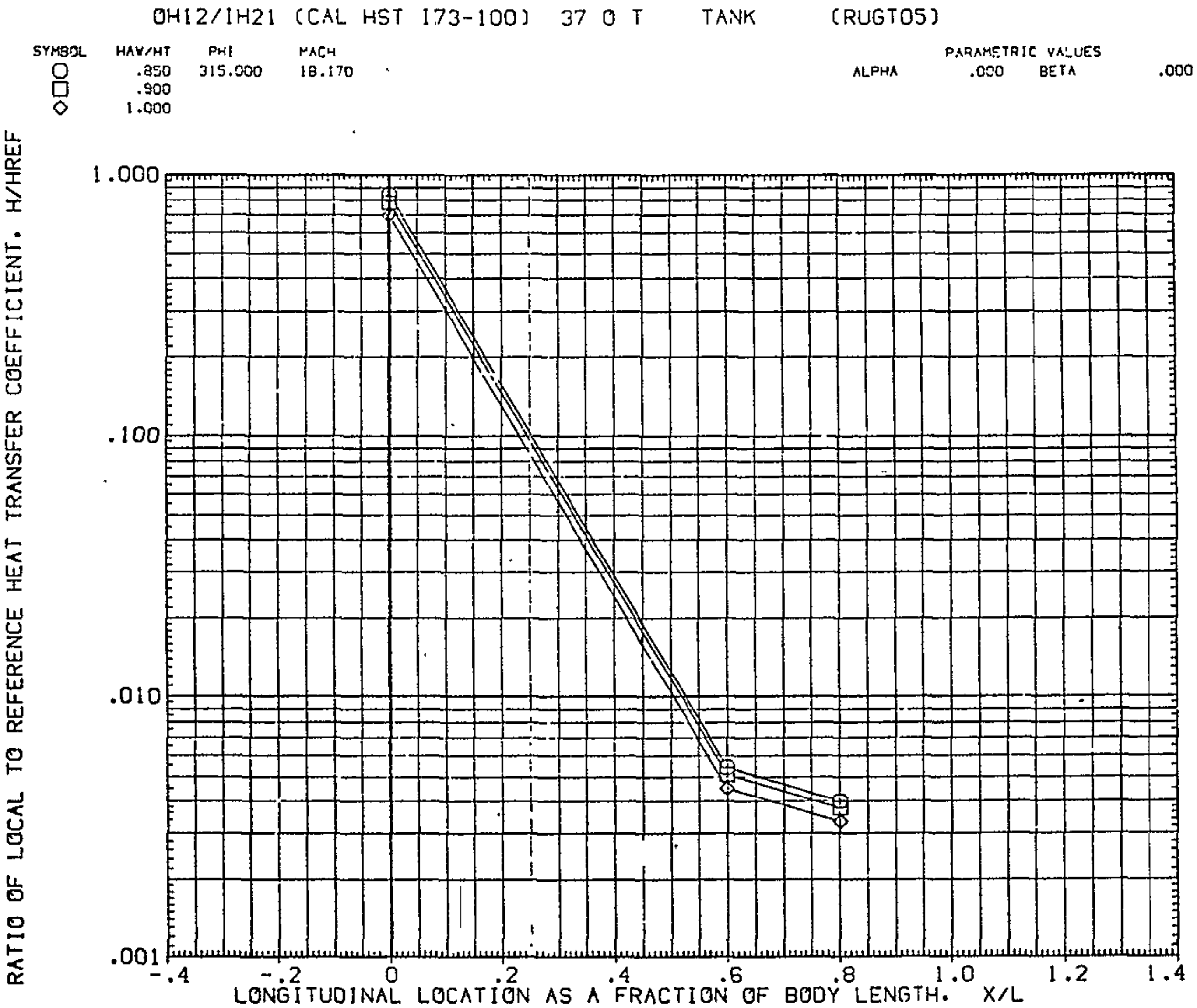


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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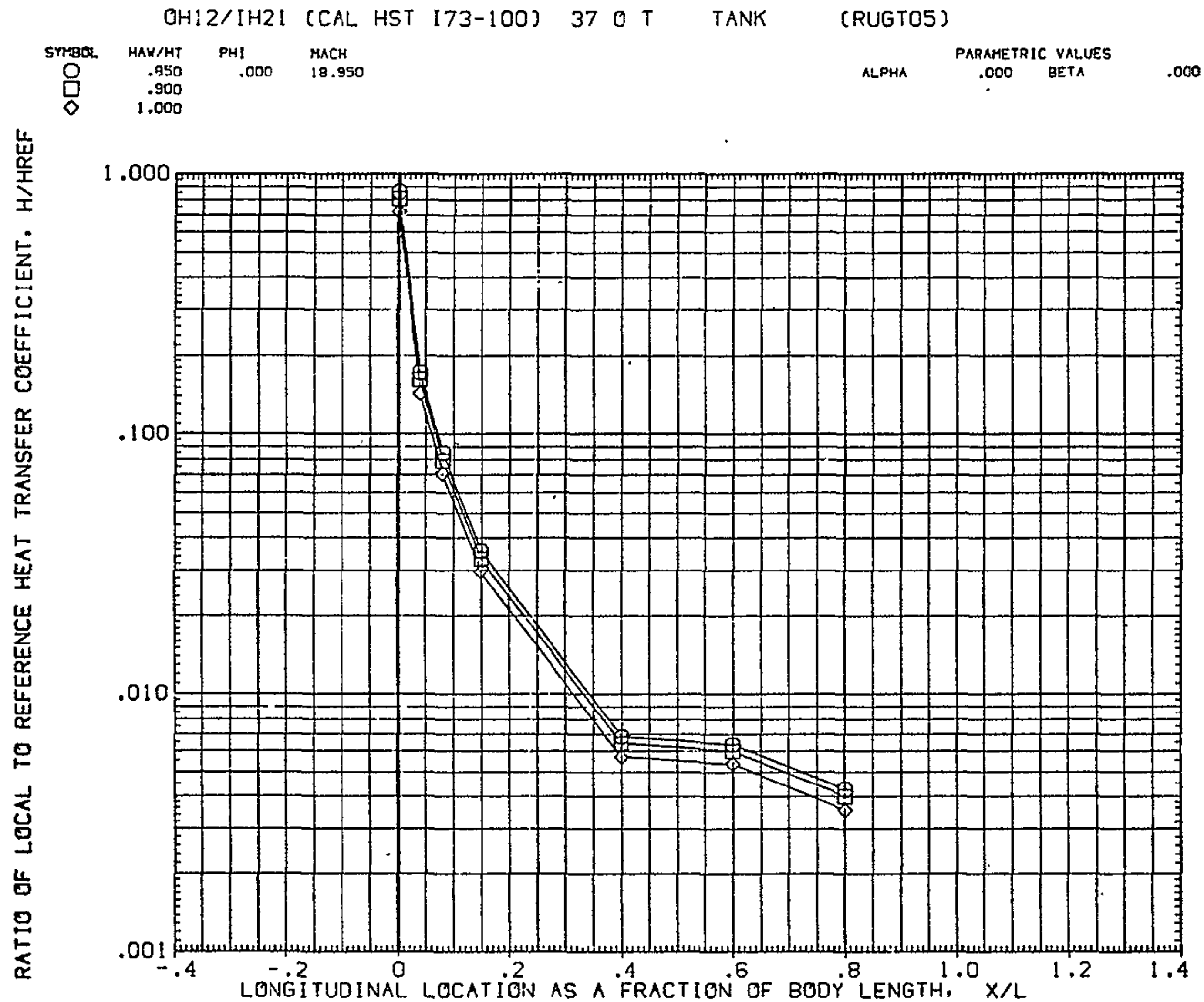


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

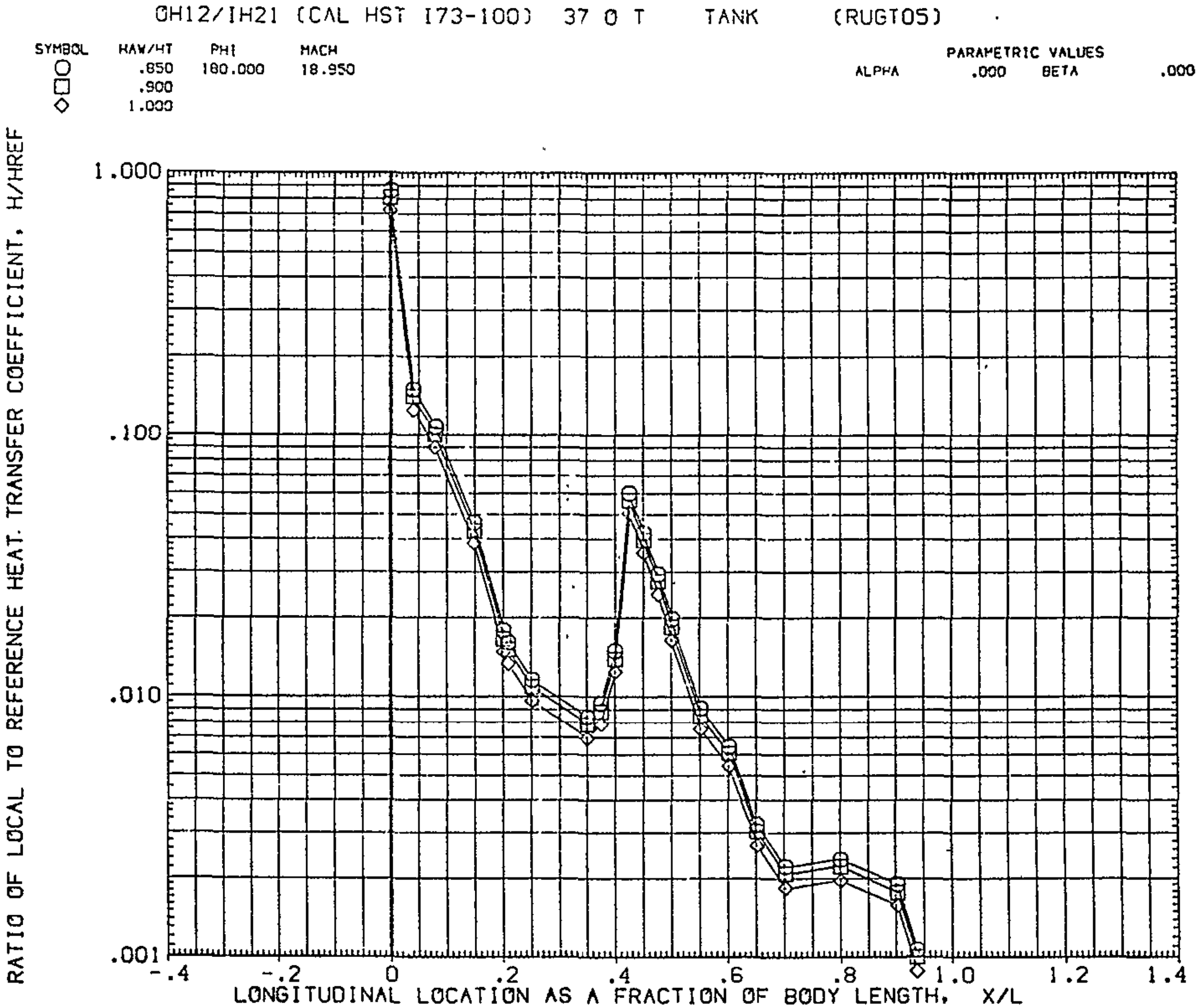


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

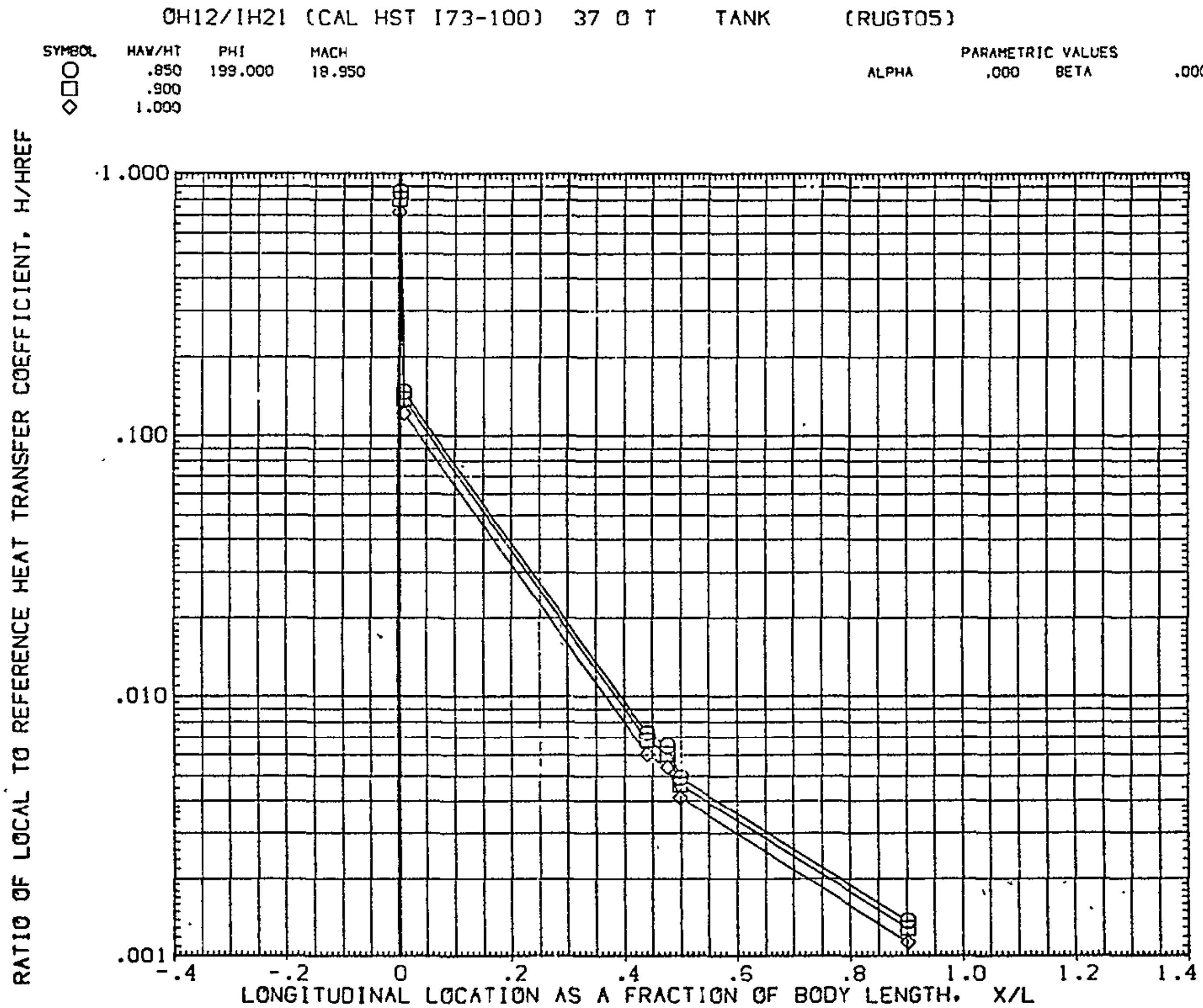


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

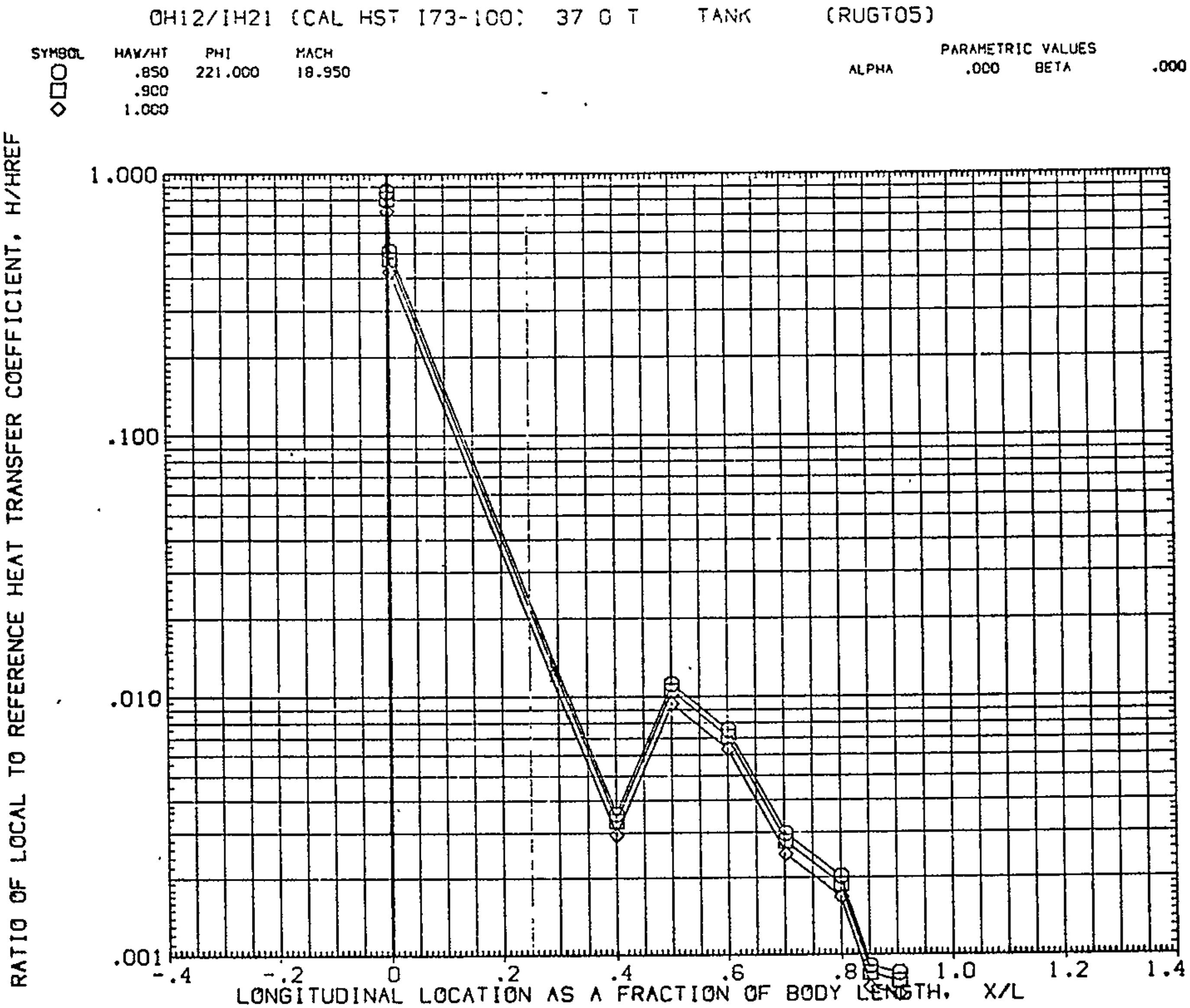


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T TANK (RUGT05)

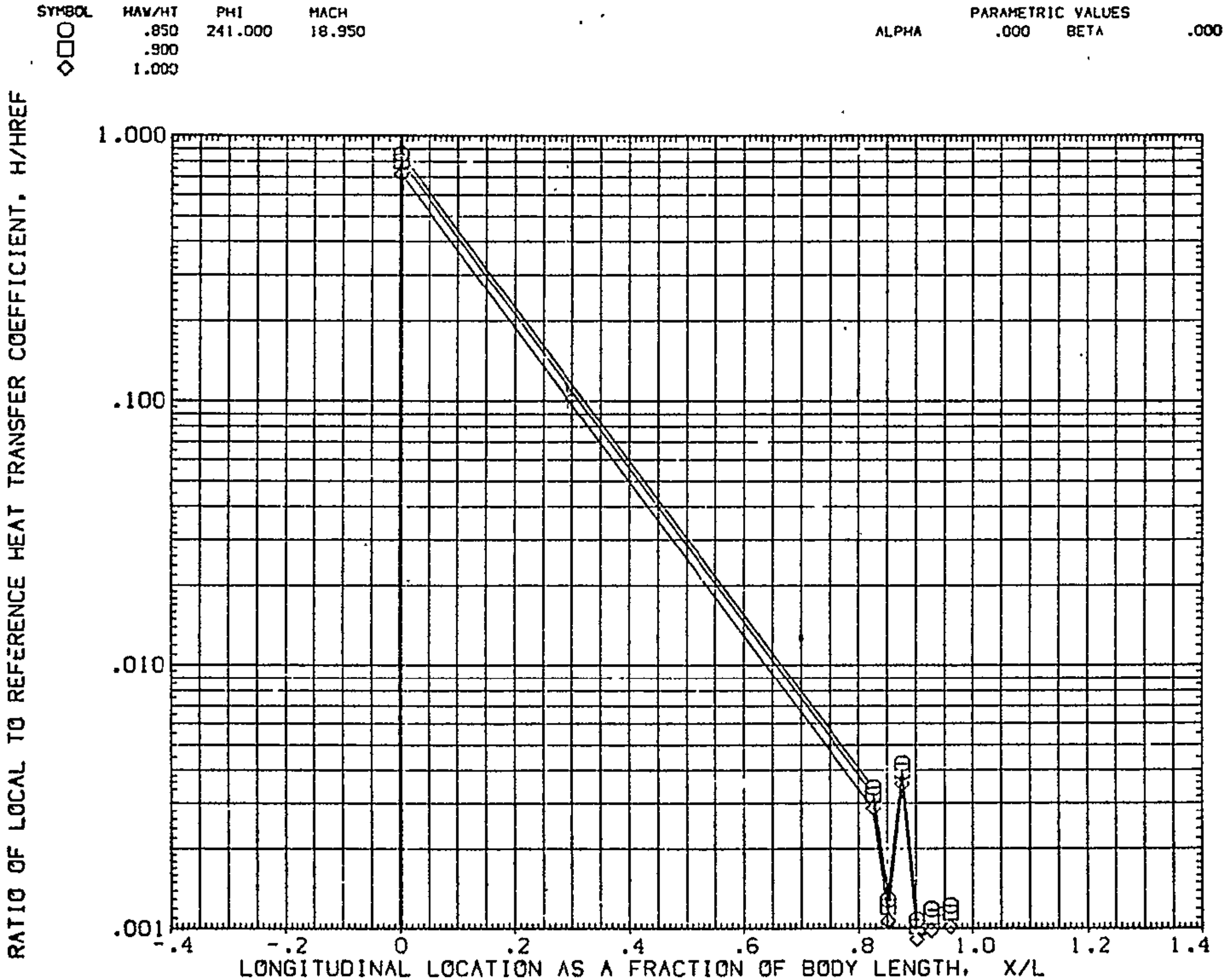


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0H12/IH21 (CAL HST 173-100) 37 0 T TANK (RUGT05)

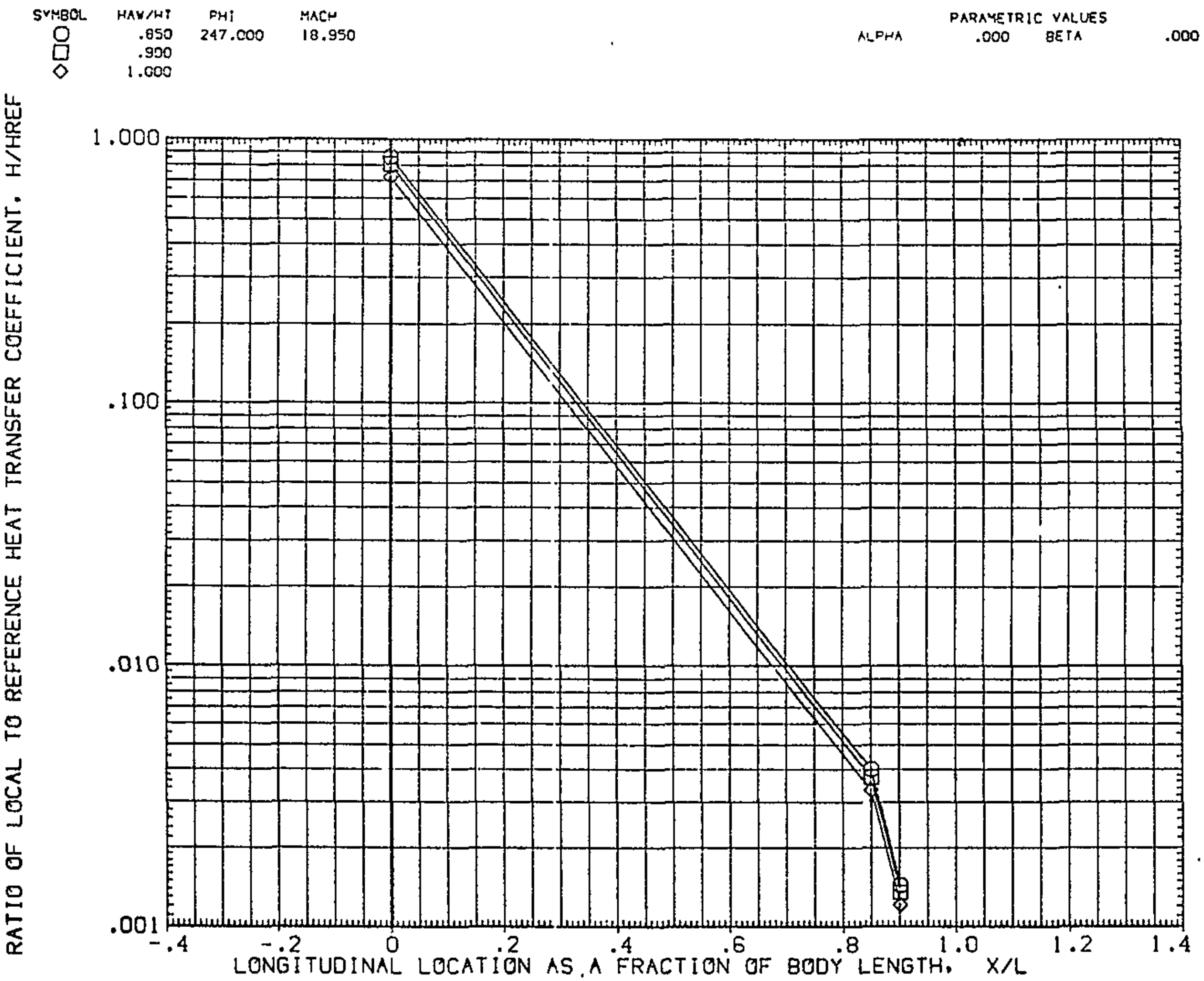
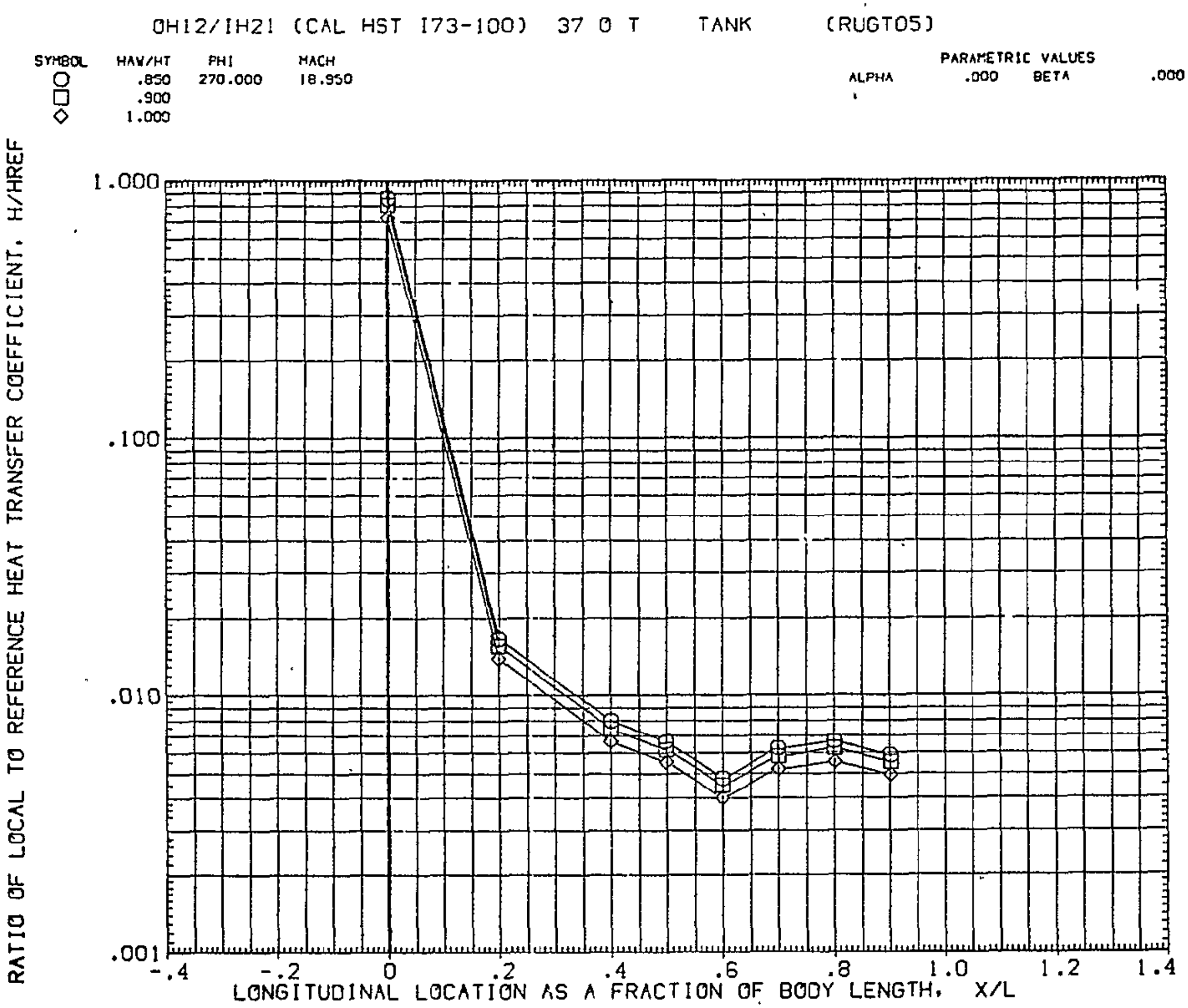


FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0



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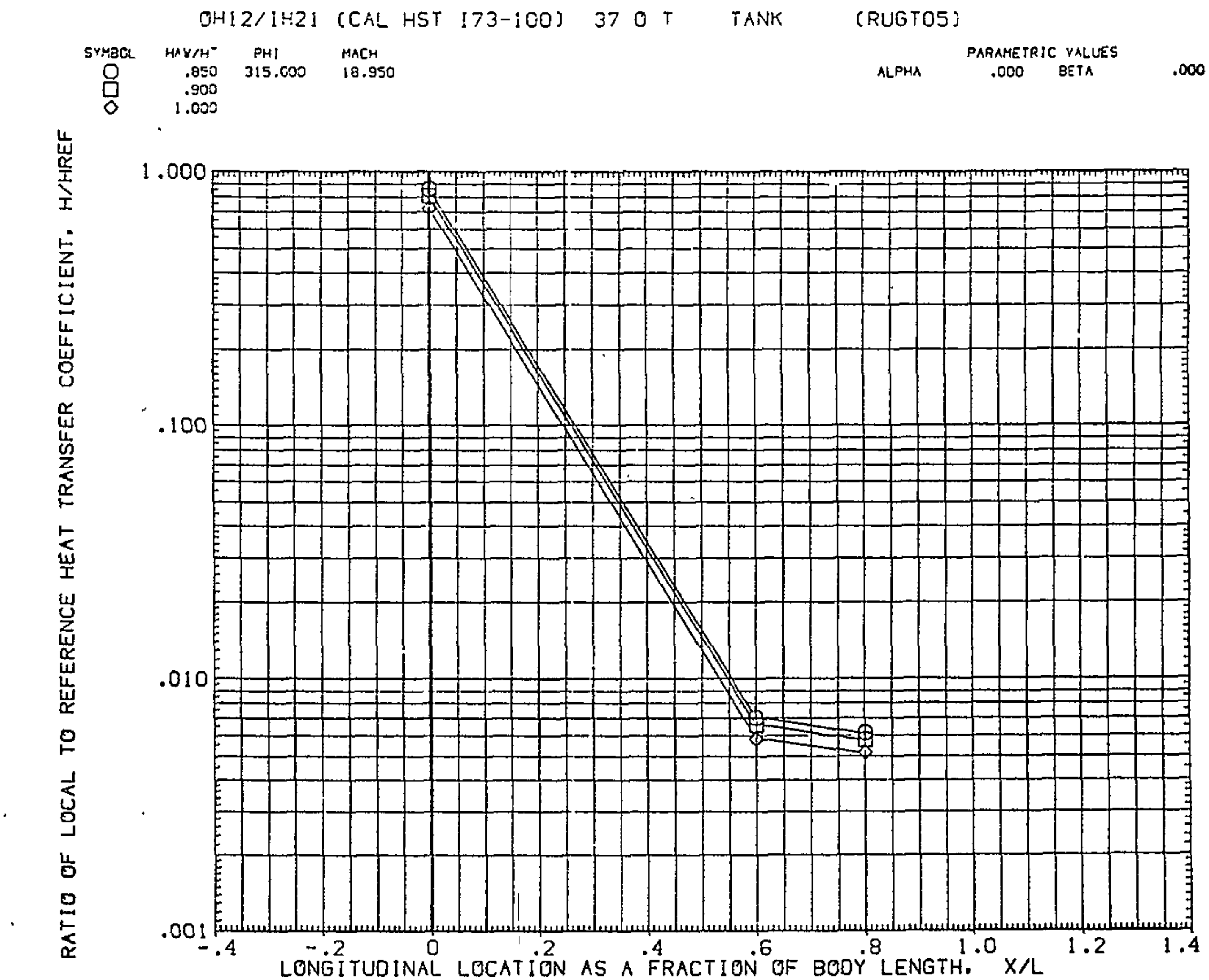

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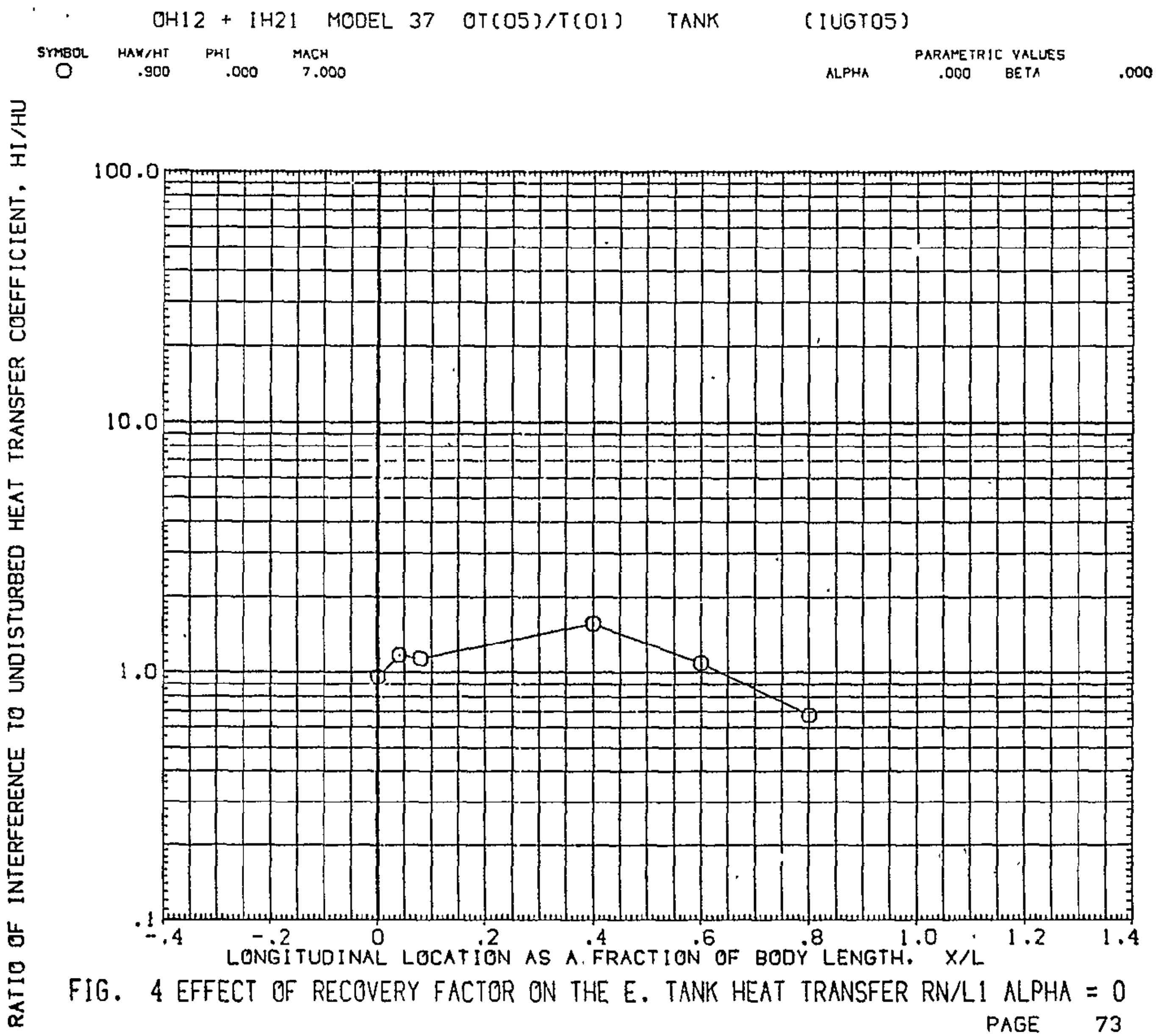

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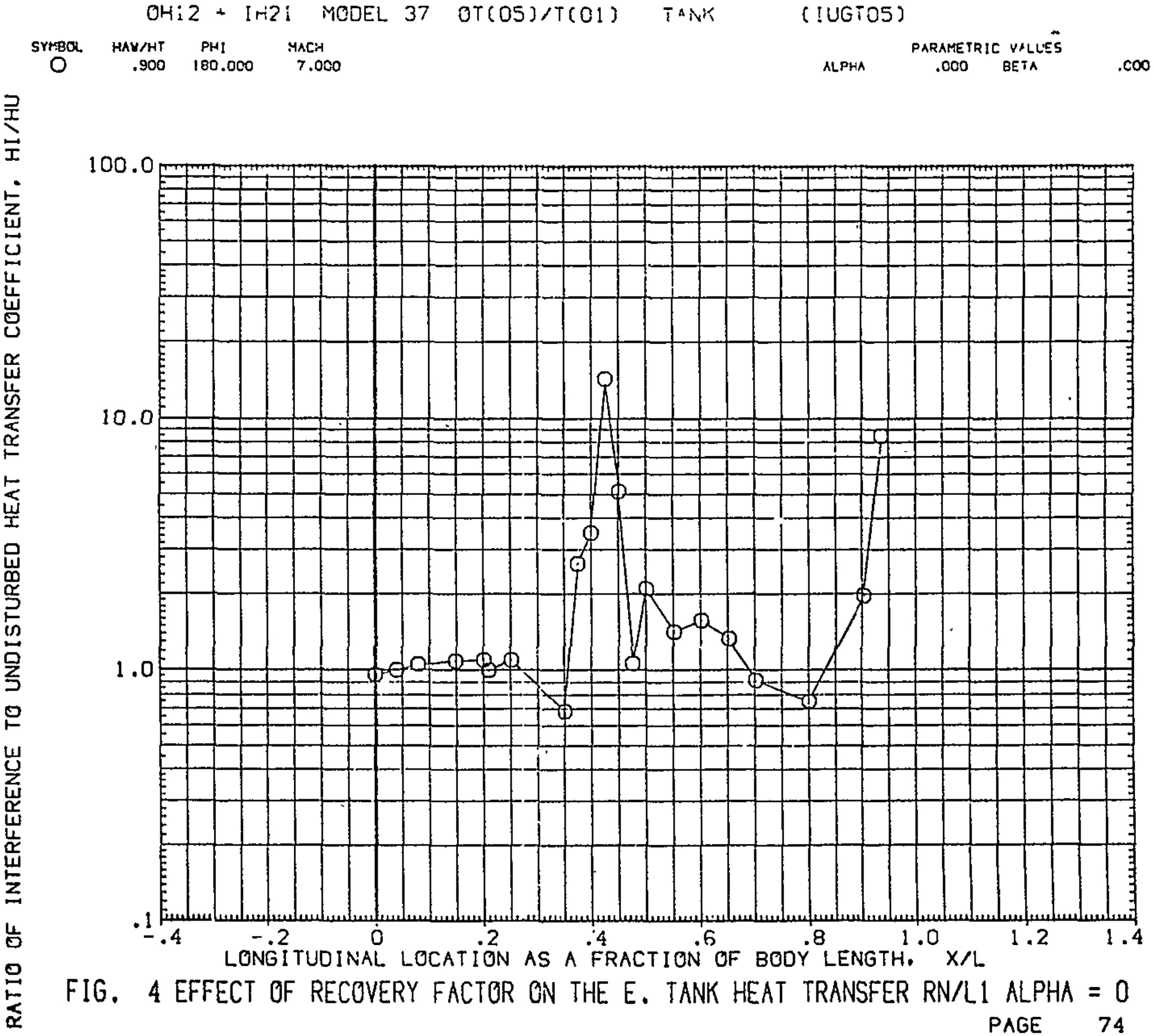


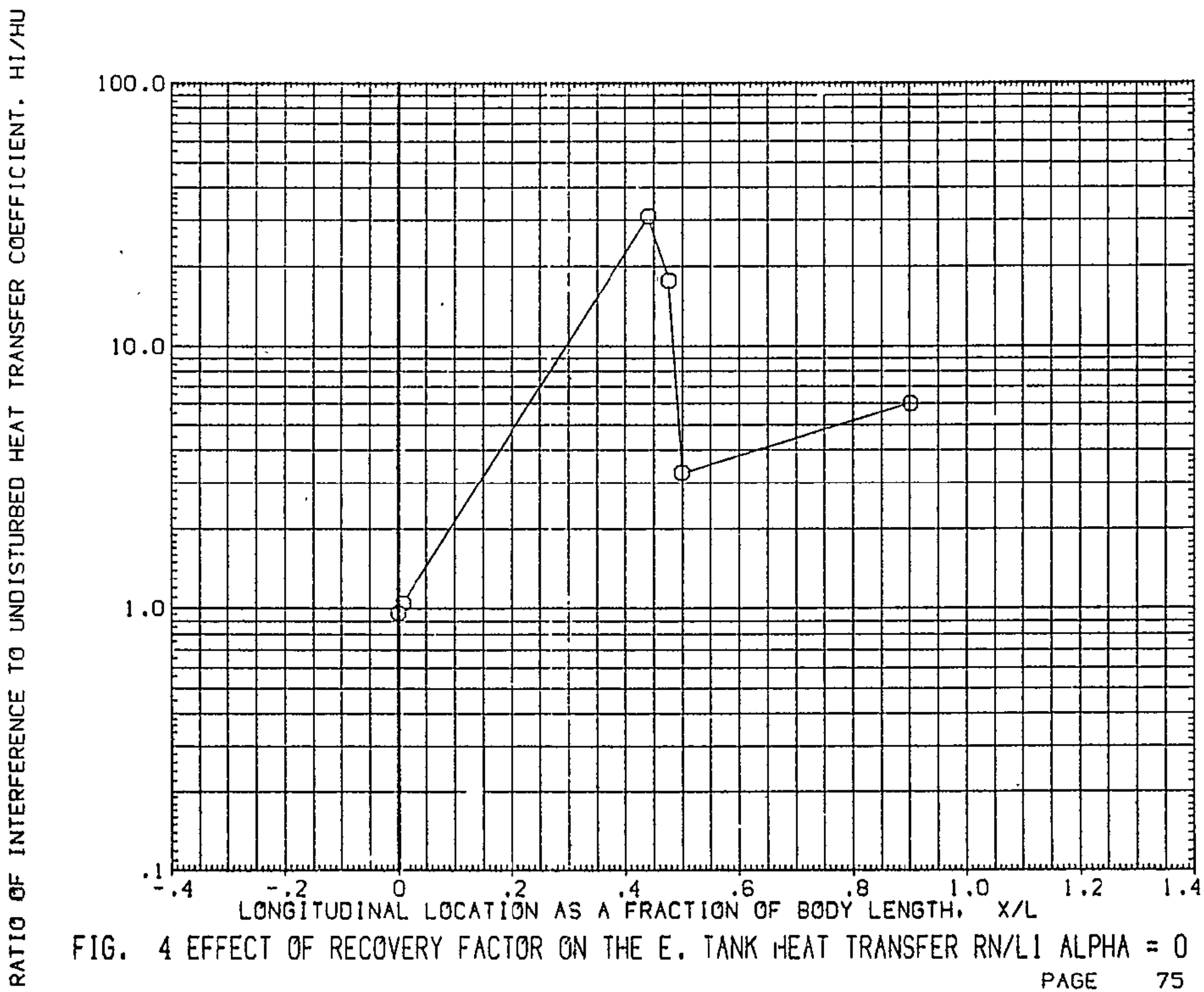
FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	199.000	7.000

PARAMETRIC VALUES

ALPHA .000 BETA .000



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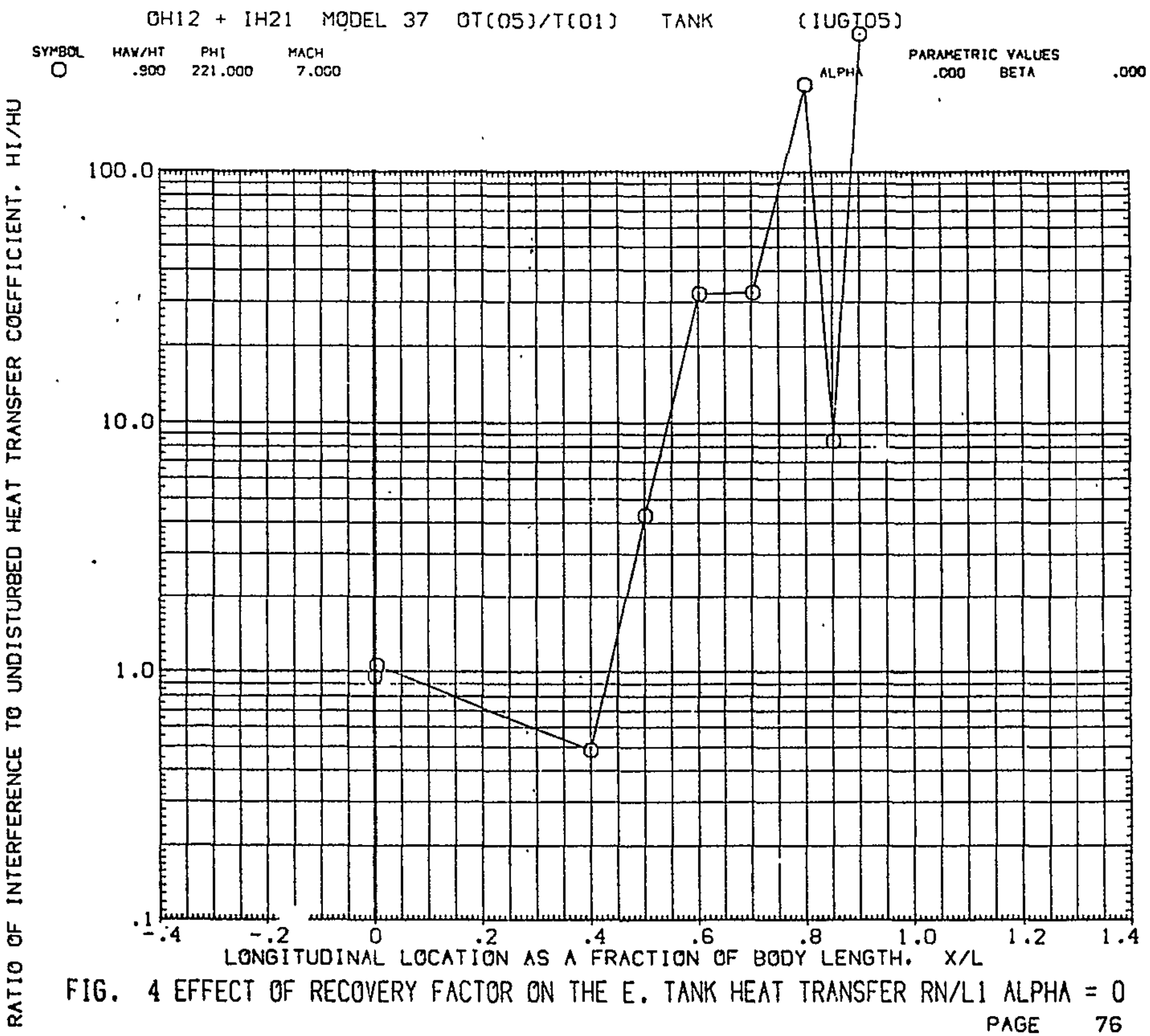

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

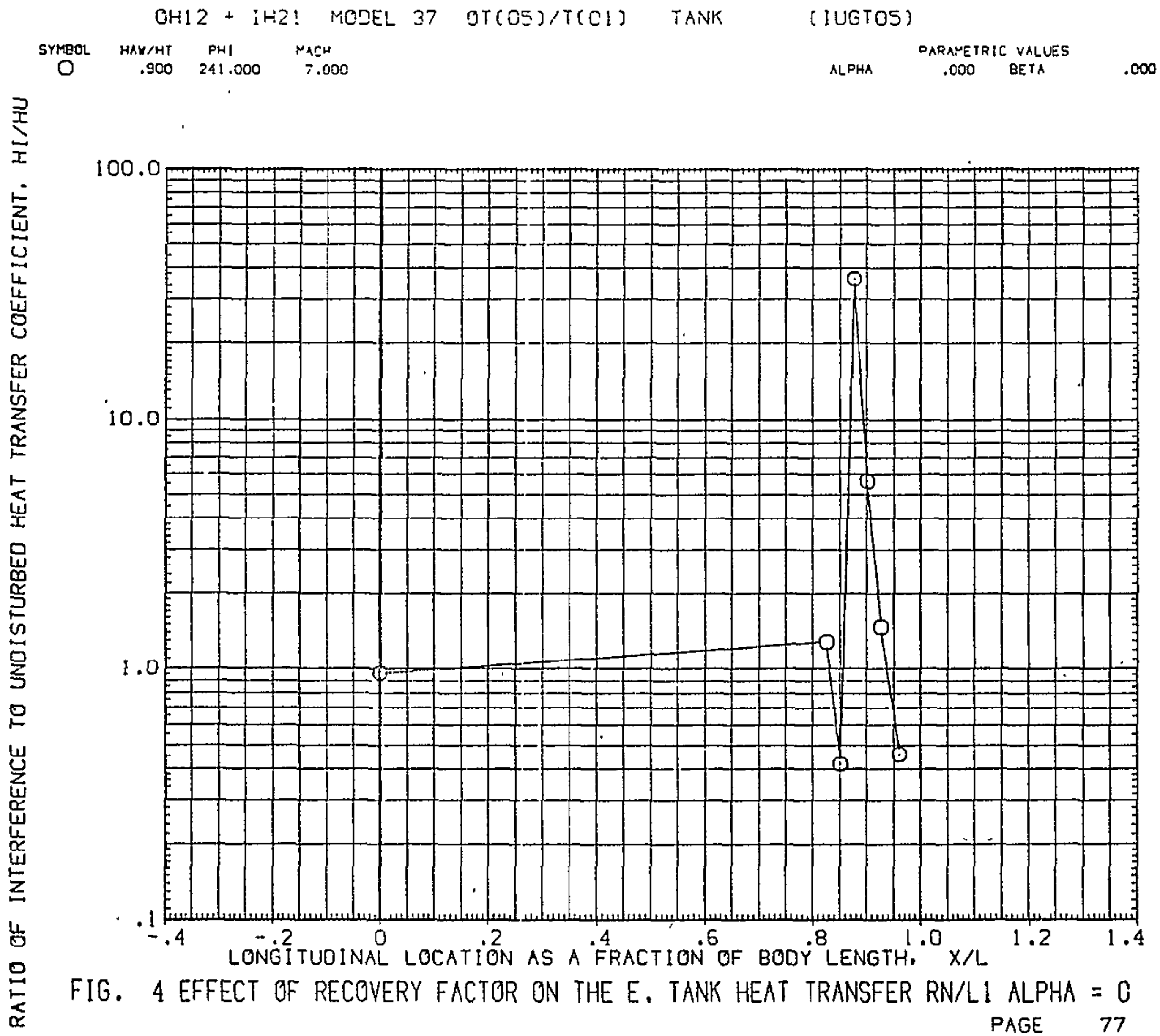

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

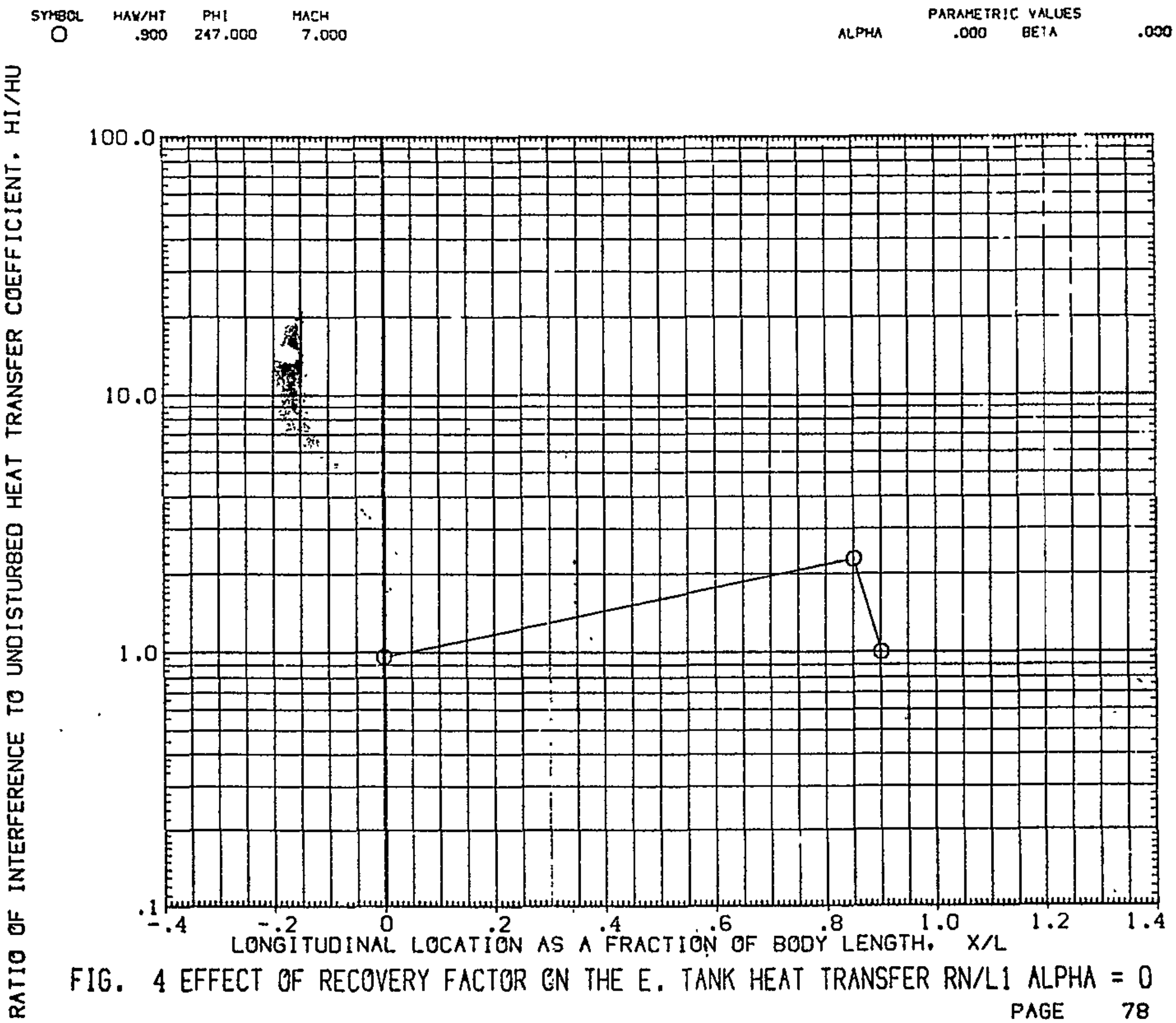

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	270.000	7.000

PARAMETRIC VALUES
ALPHA .000 BETA .000

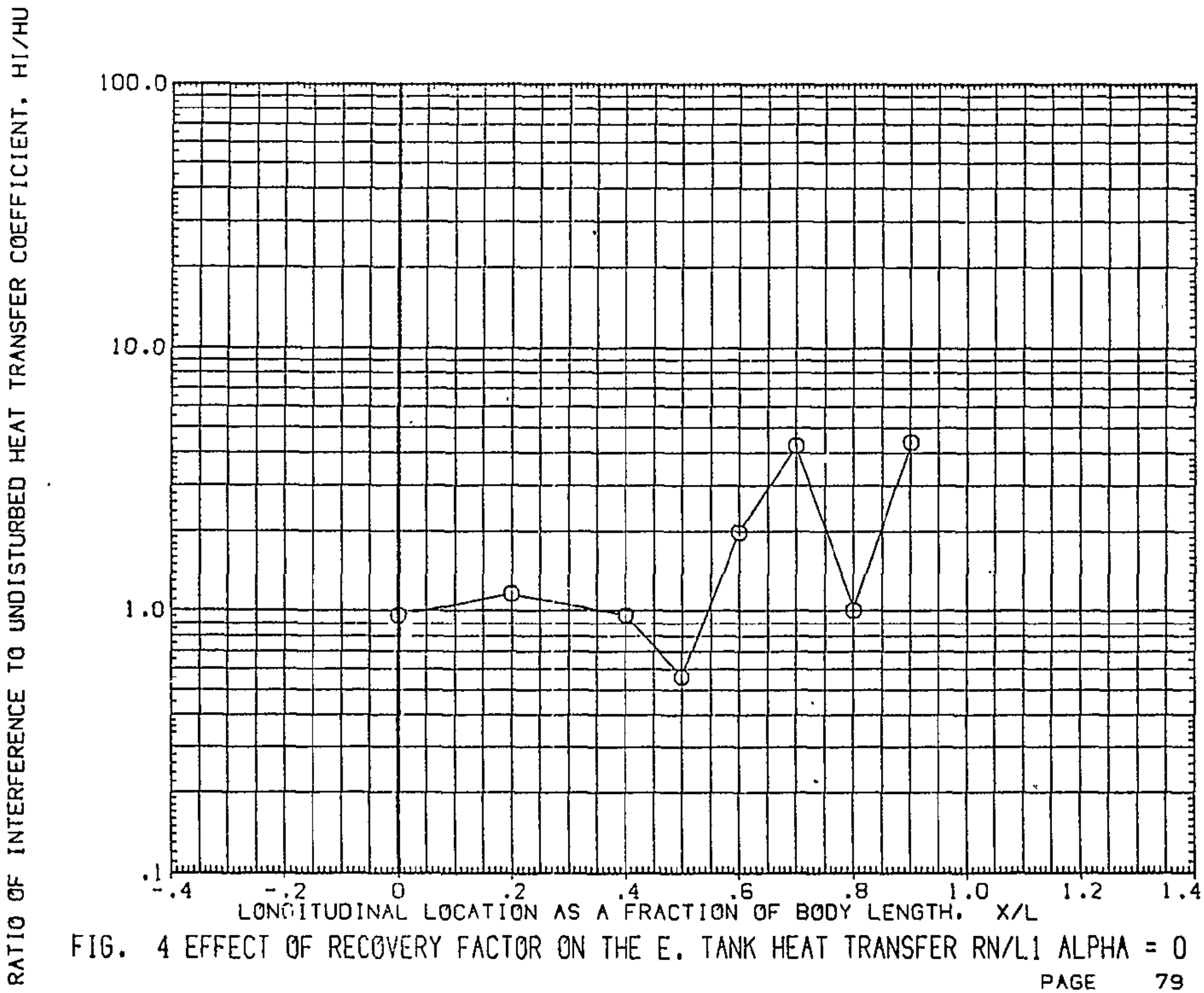

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

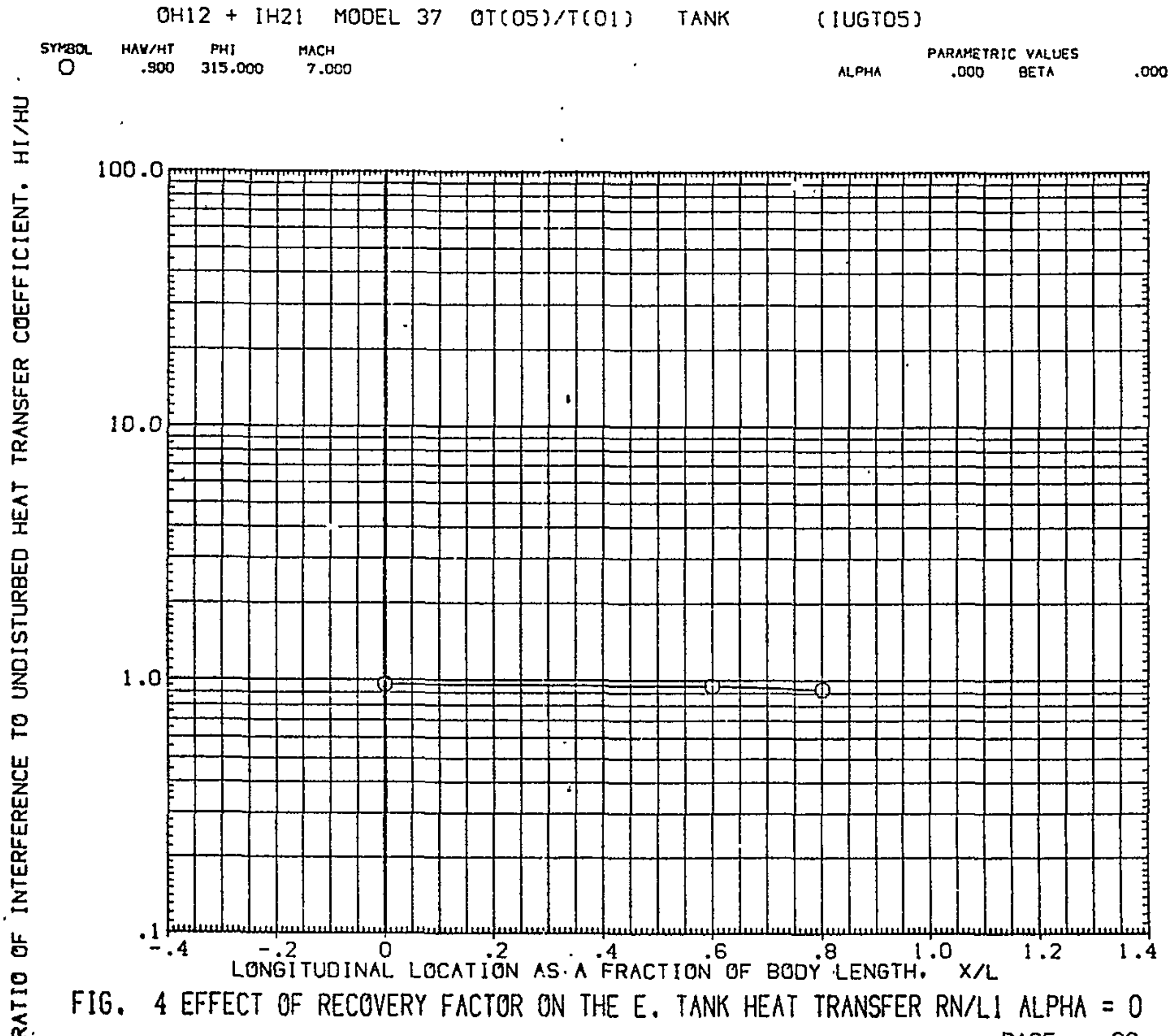

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

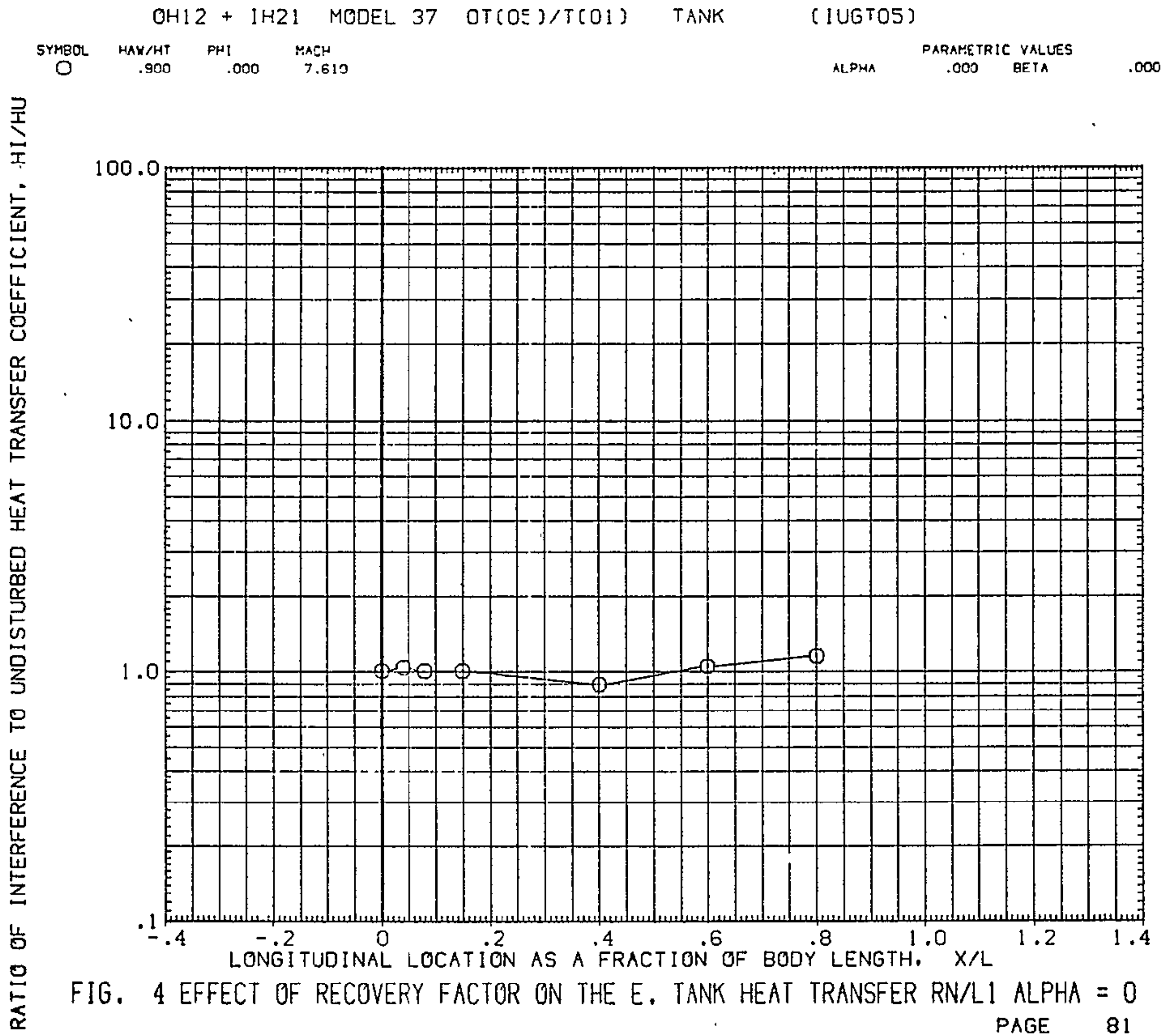

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	180.000	7.610	ALPHA	.000	BETA	.000

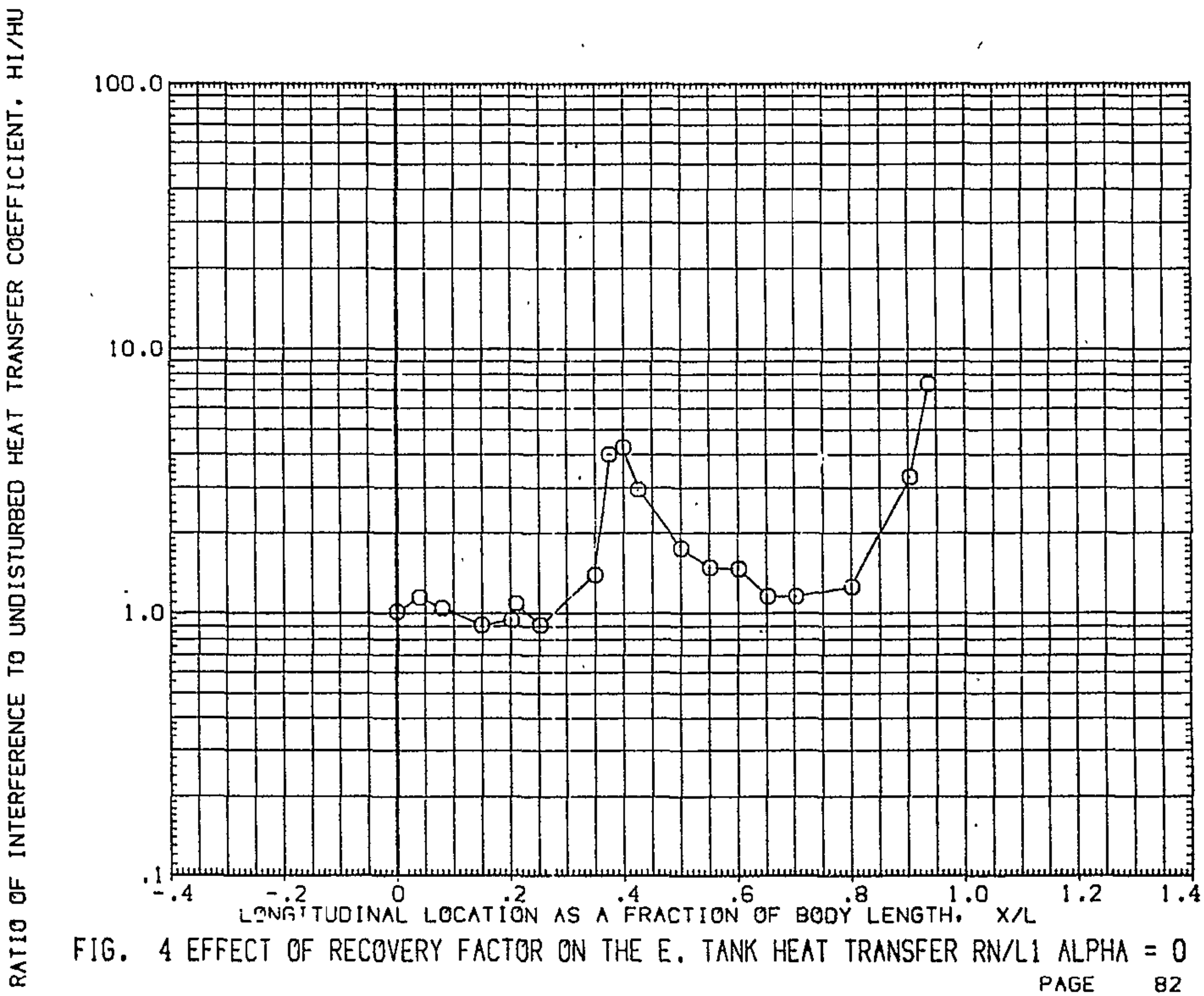

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

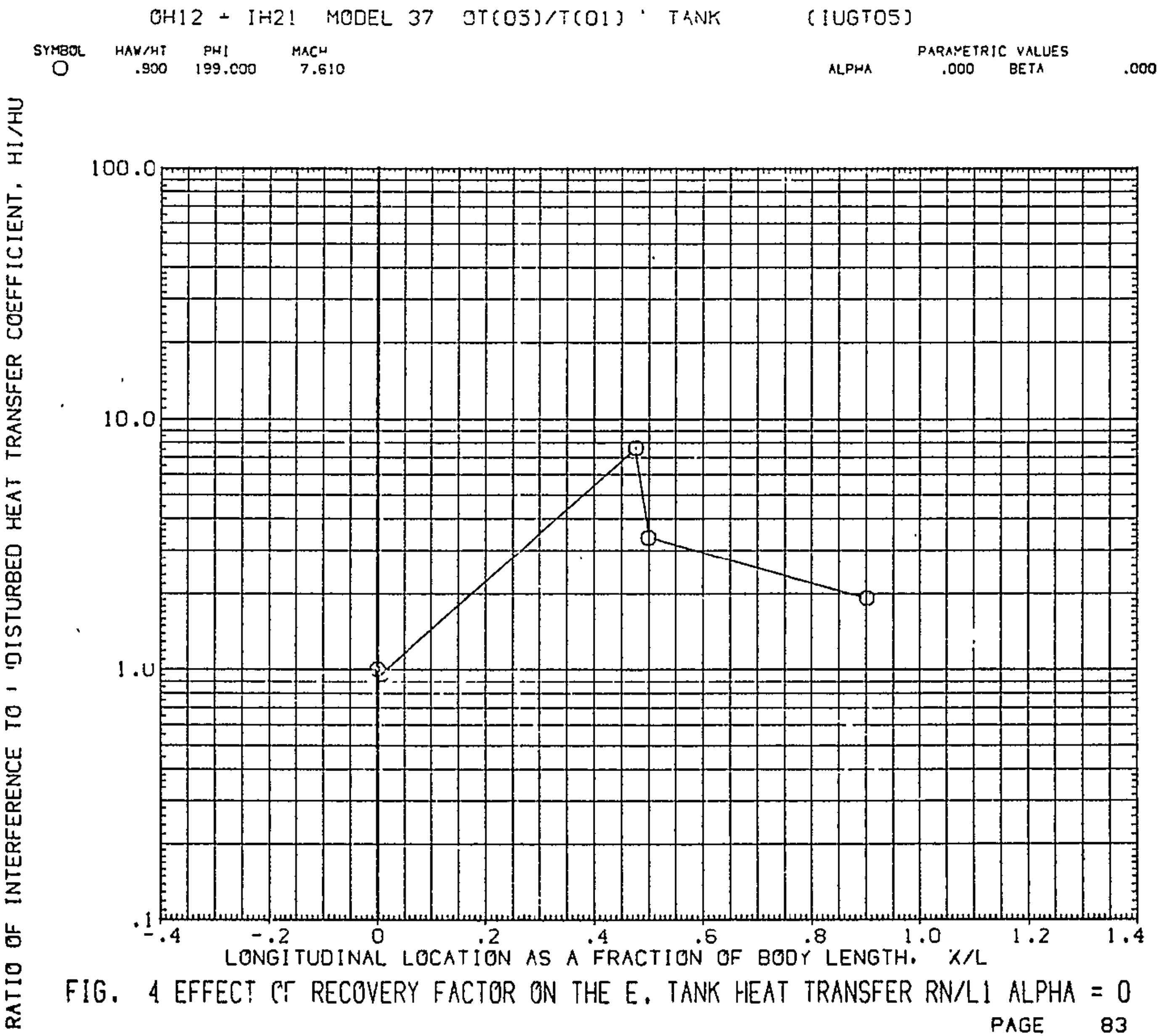

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

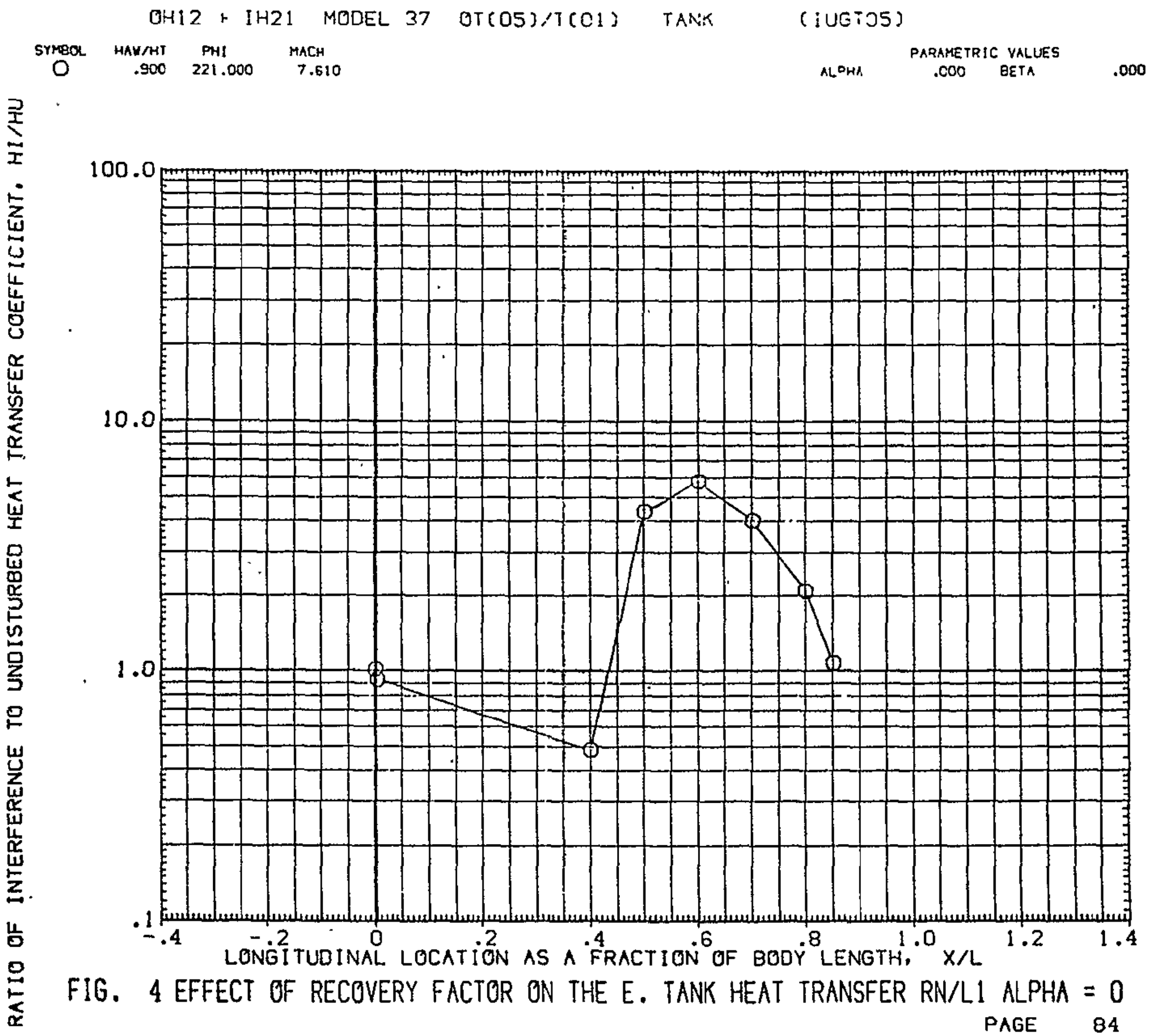

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

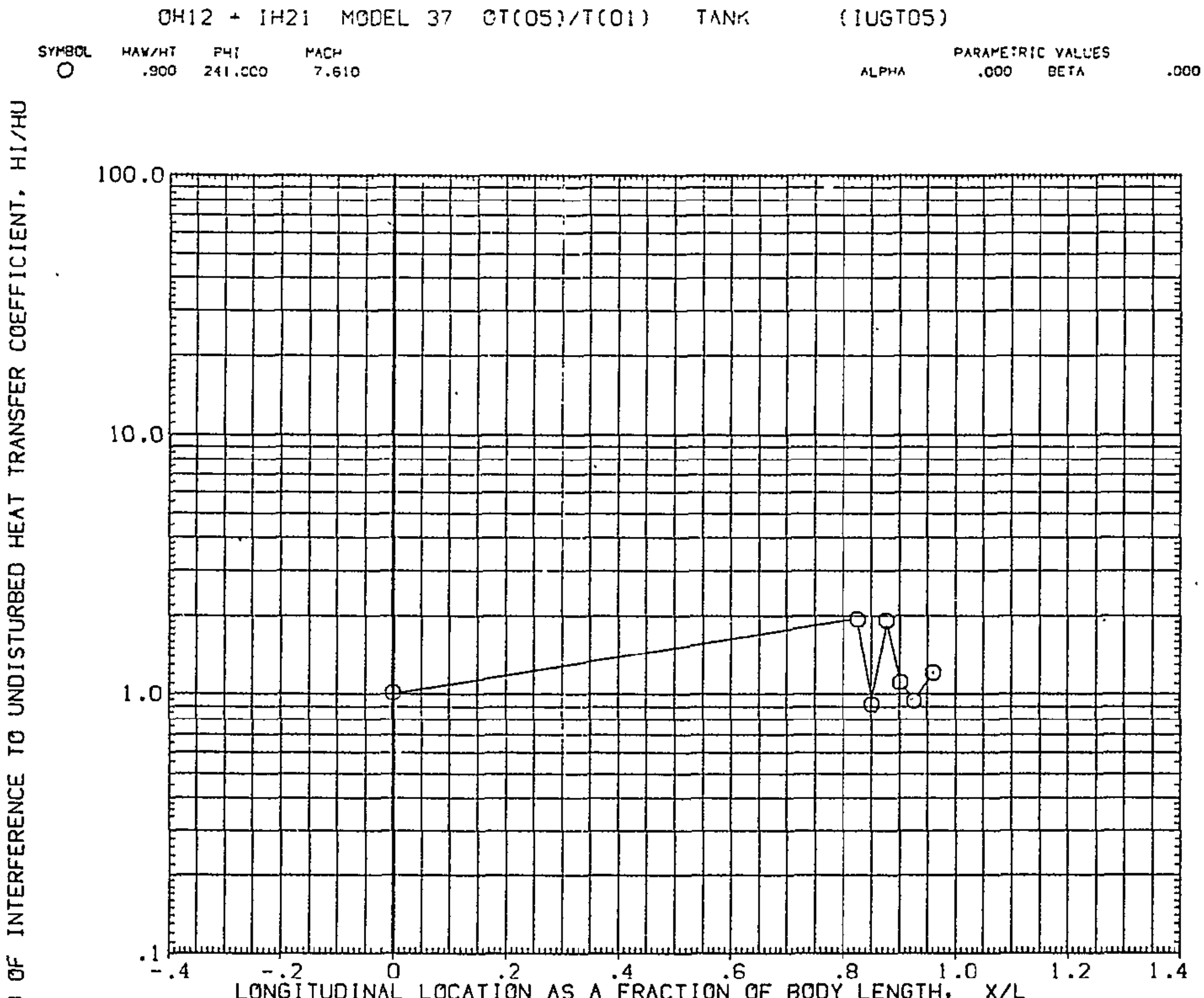

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	247.000	7.610

PARAMETRIC VALUES

ALPHA .000 BETA .000

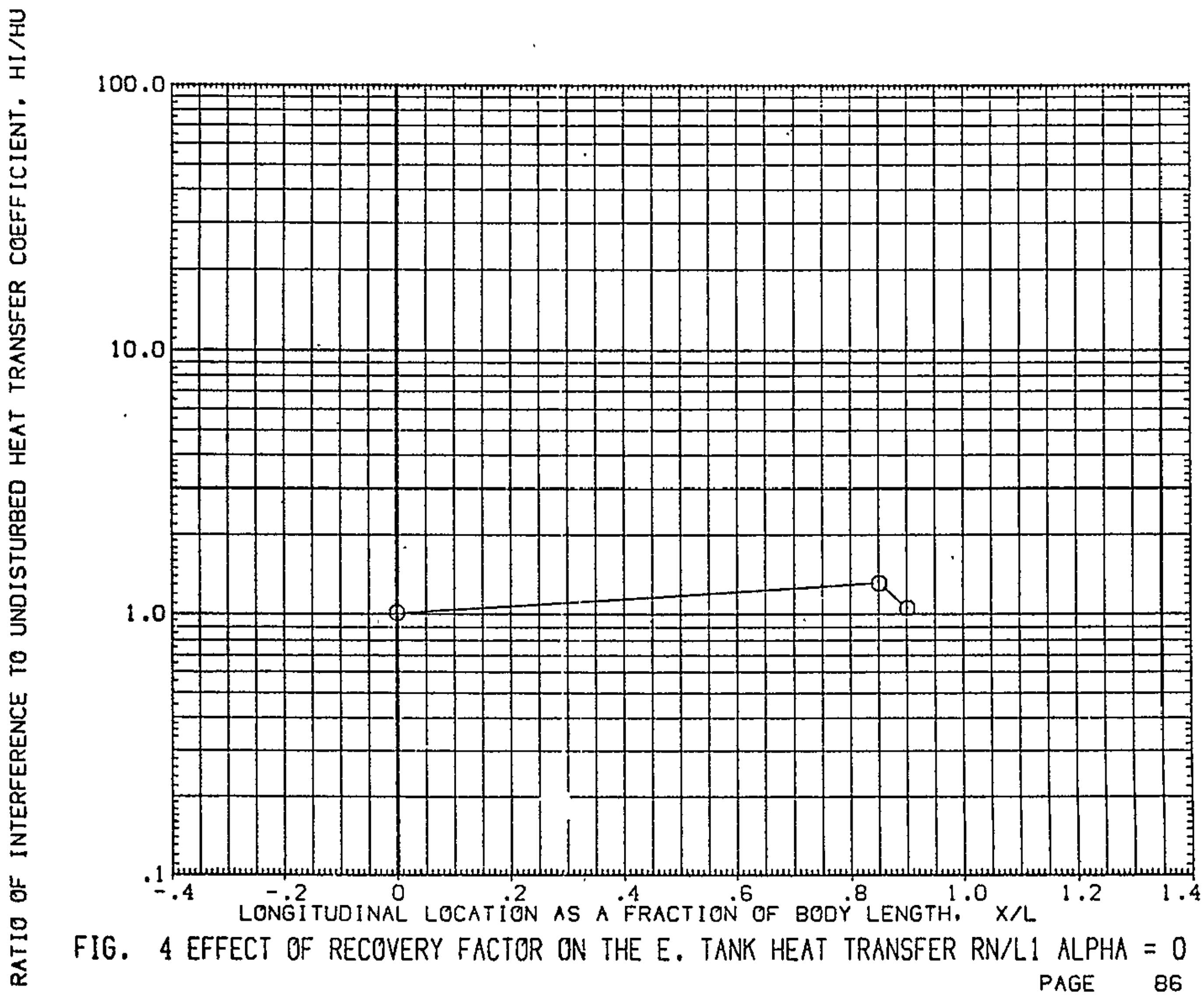

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	270.000	7.610	ALPHA	.000	BETA	.000

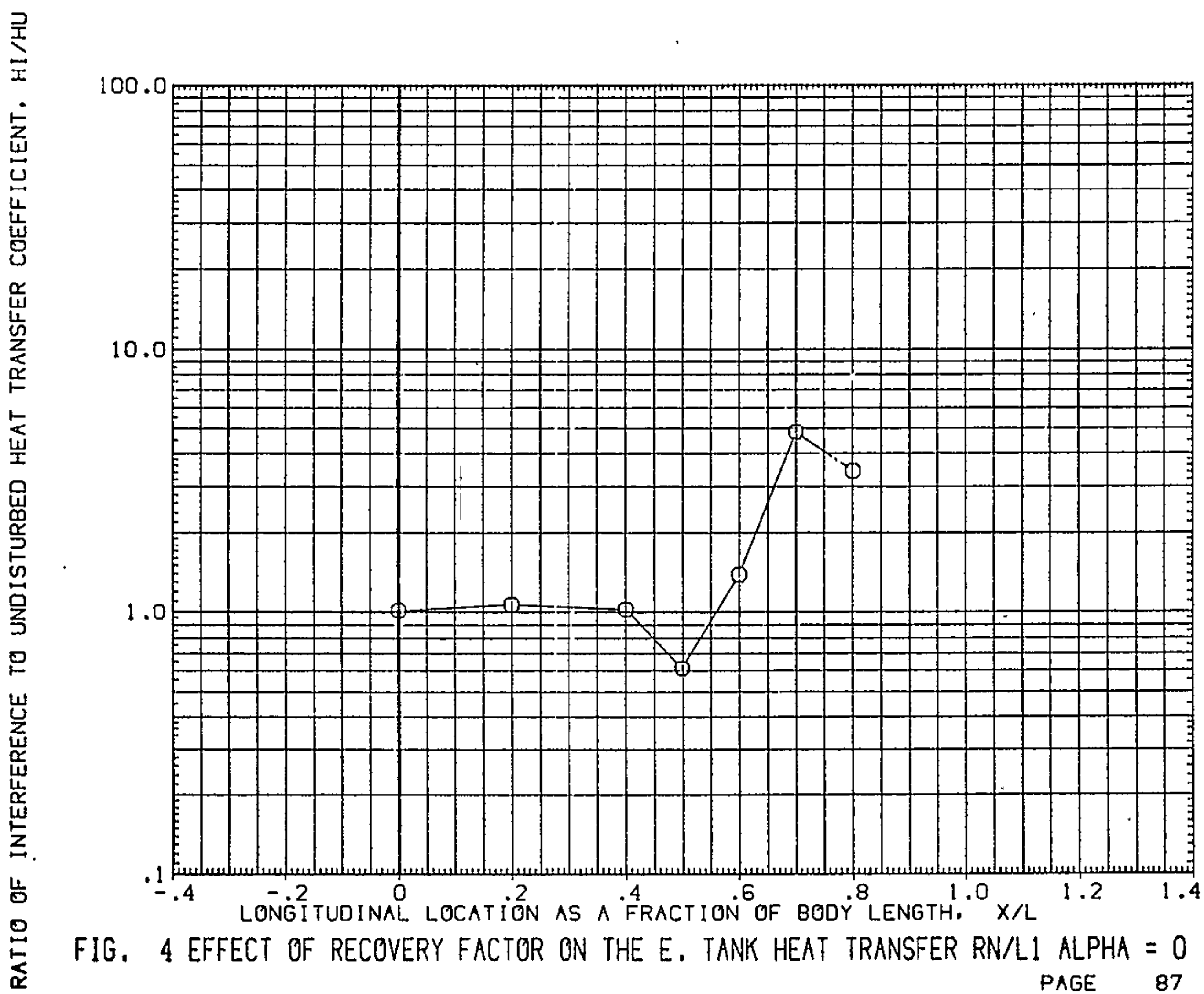

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

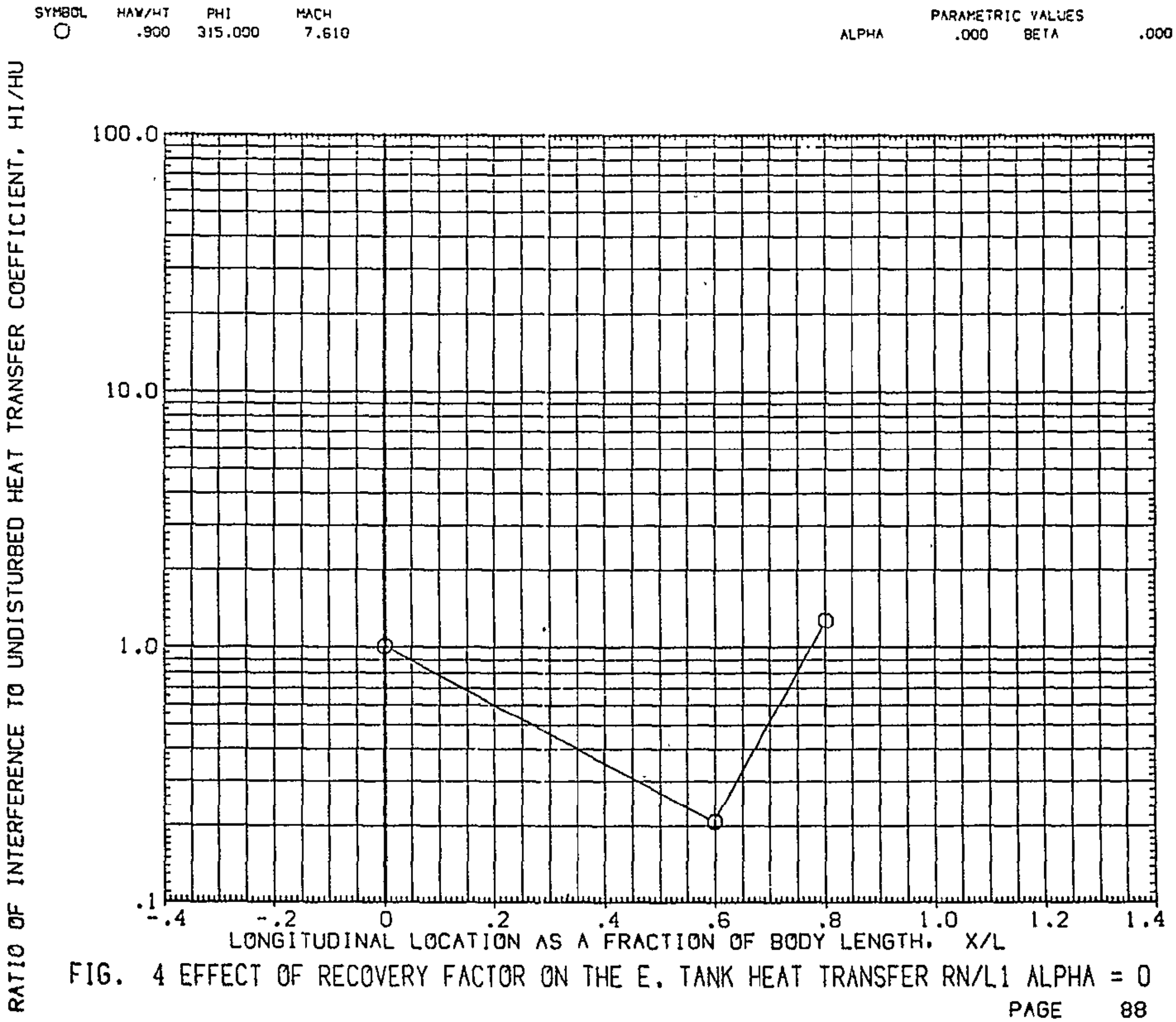

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

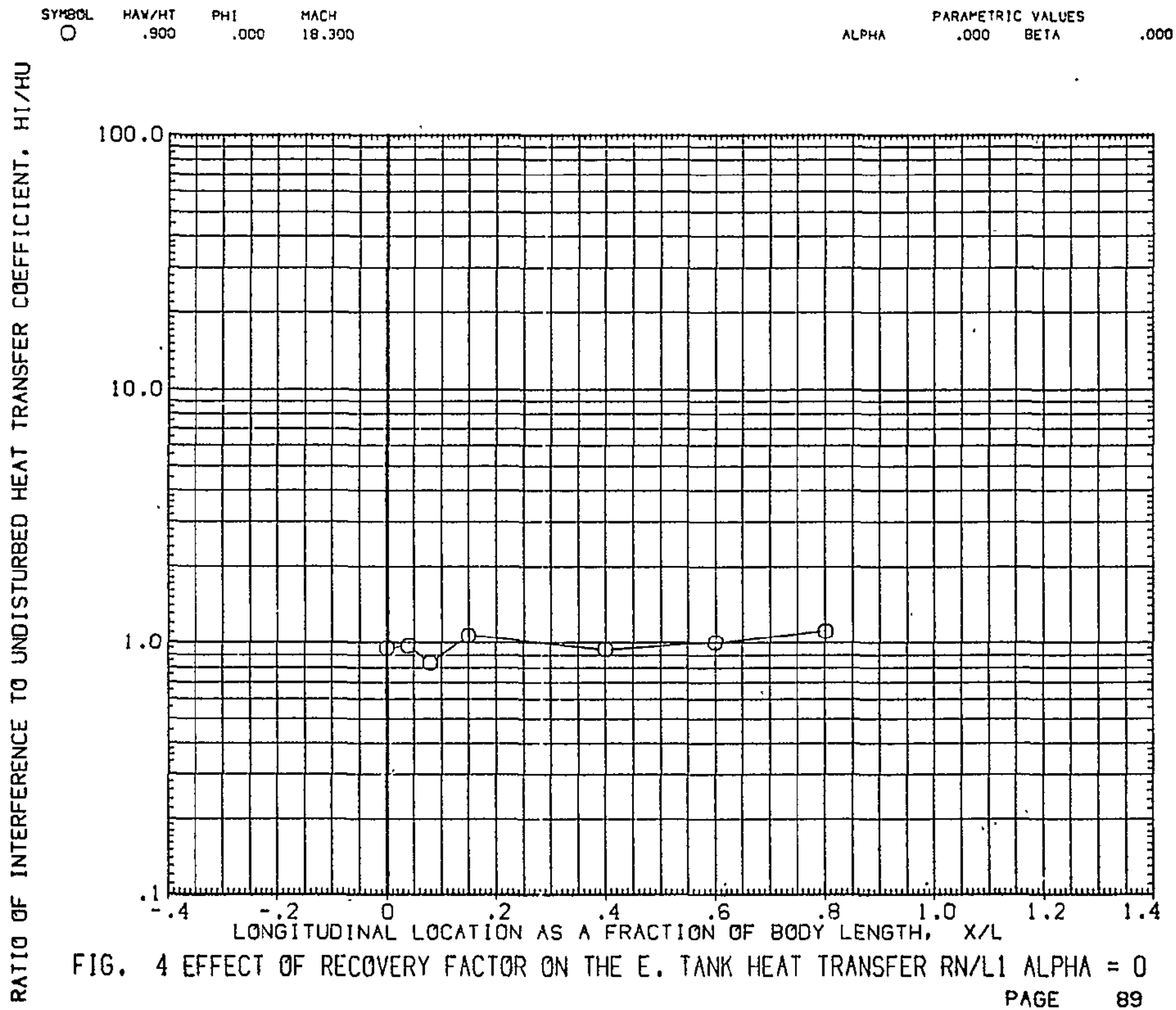

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	180.000	18.300

PARAMETRIC VALUES
ALPHA .000 BETA .000

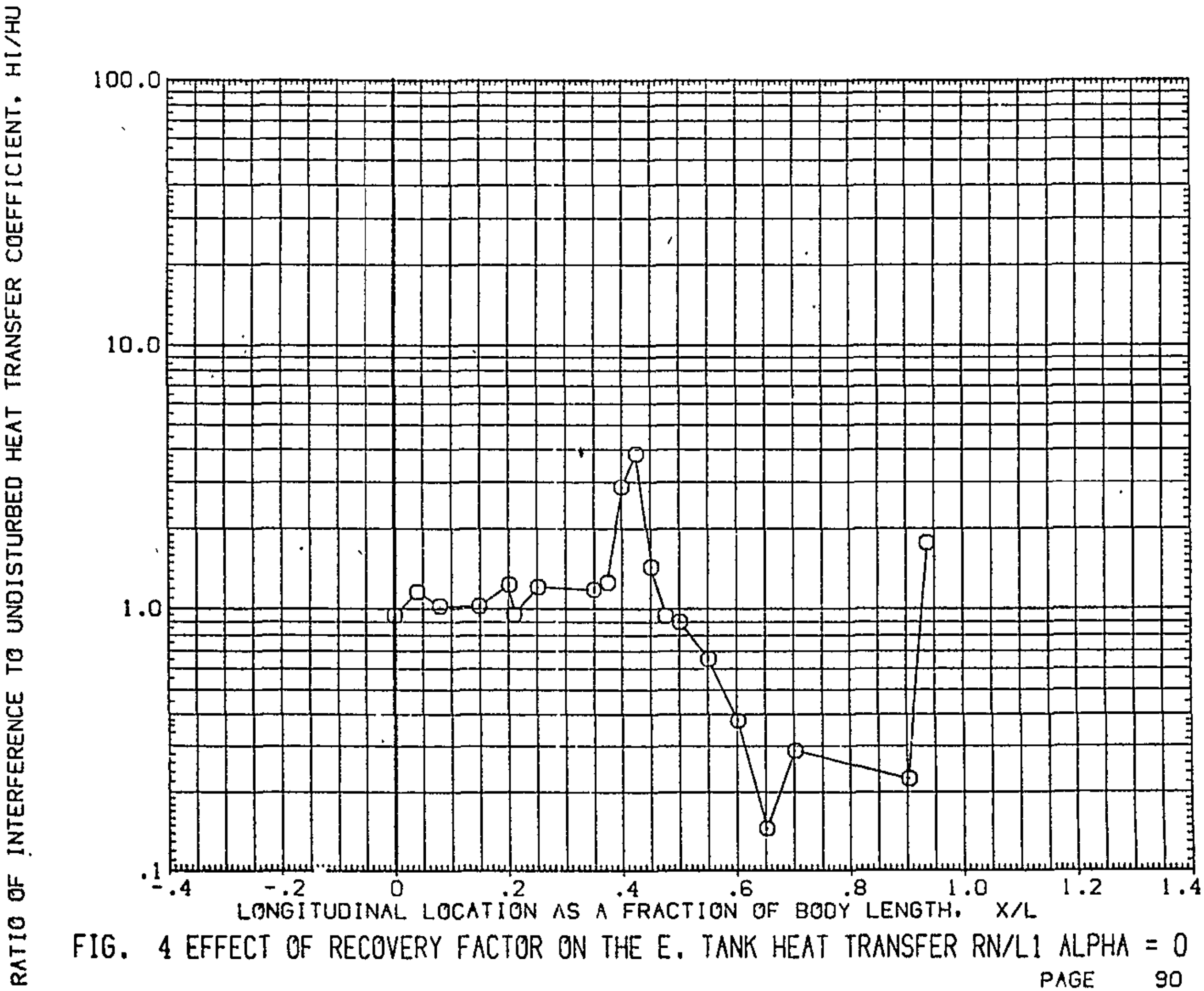

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	199.000	18.300	ALPHA	.000	BETA	.000

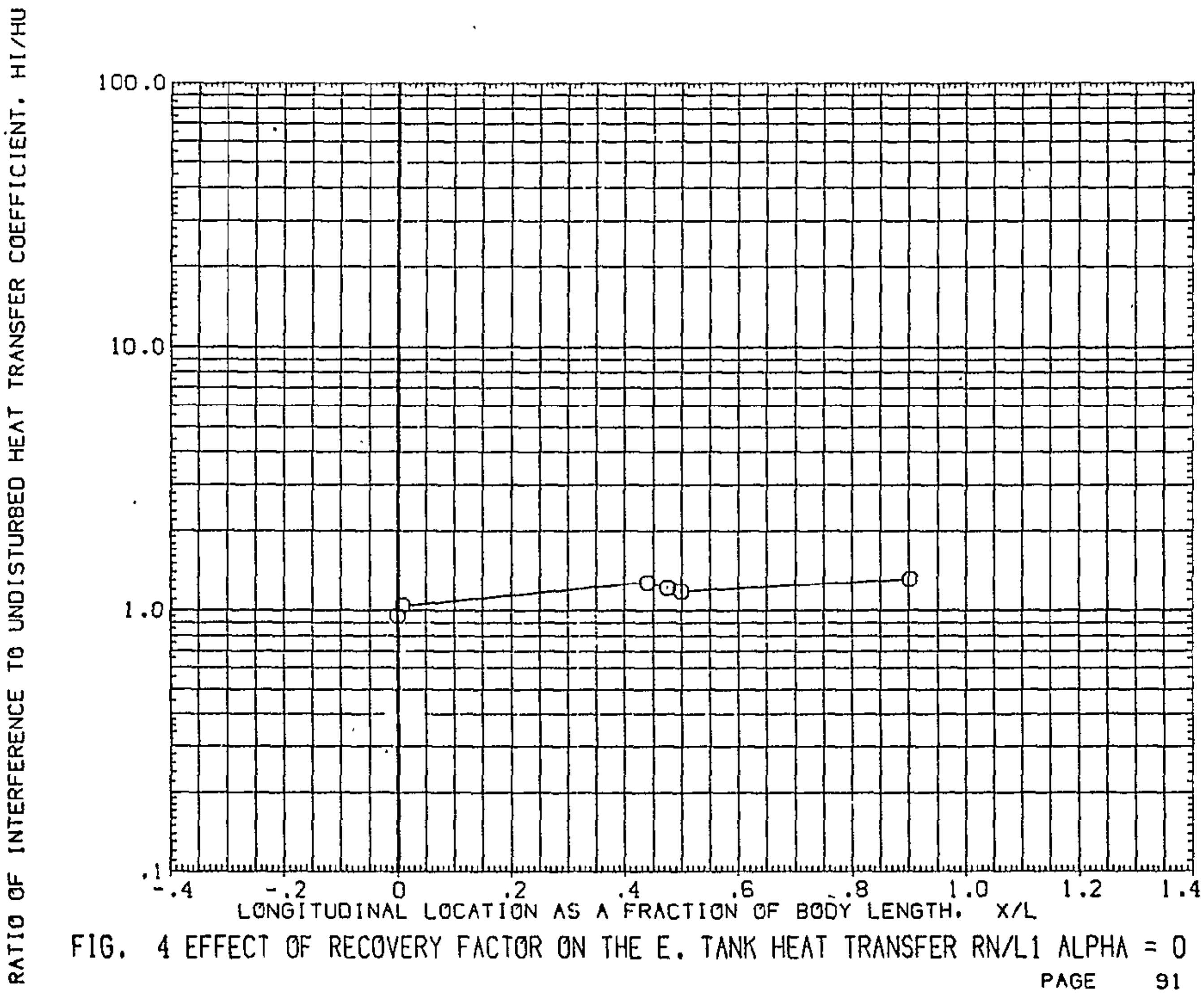

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	221.000	18.300

PARAMETRIC VALUES

ALPHA .000 BETA .000

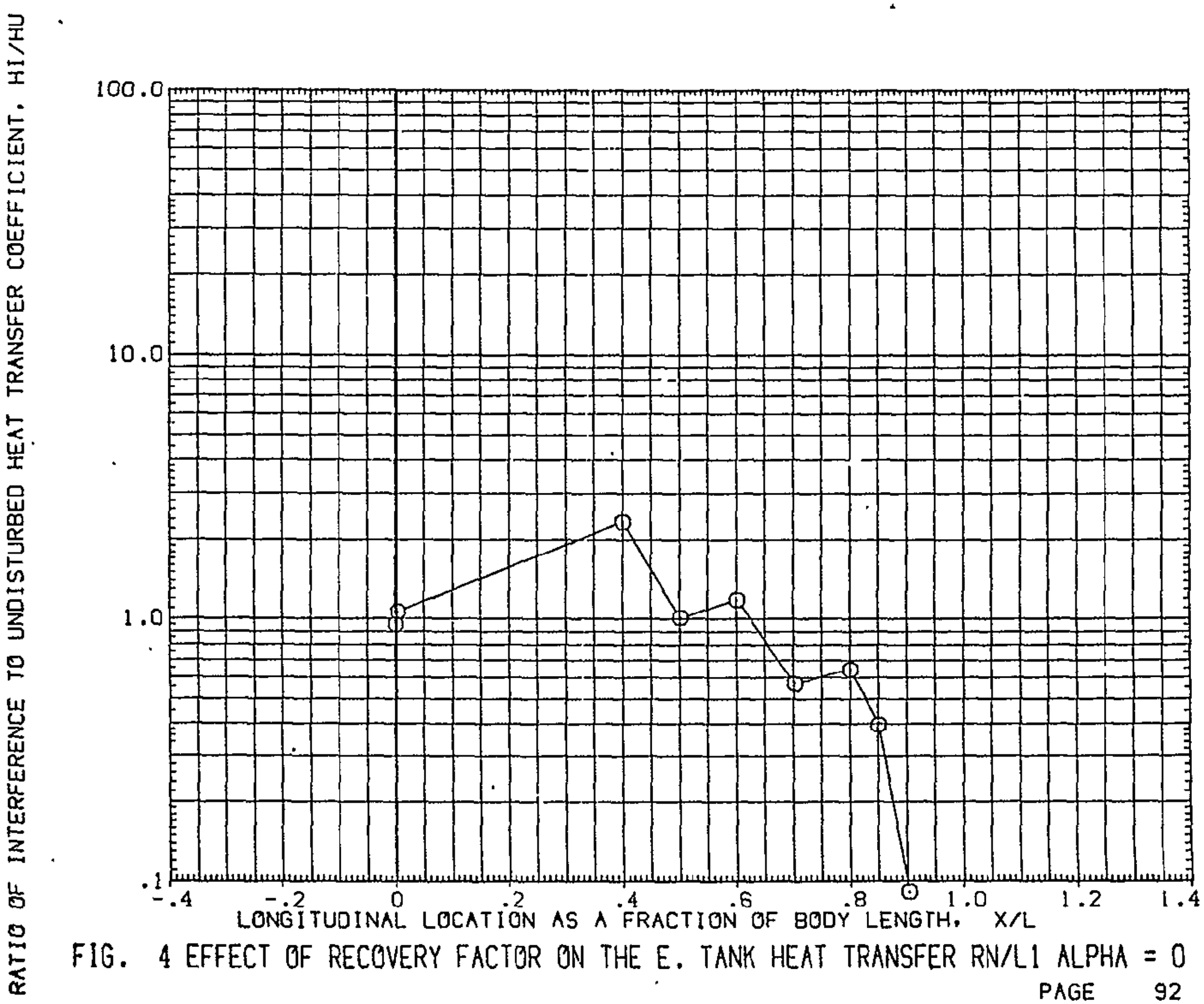

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

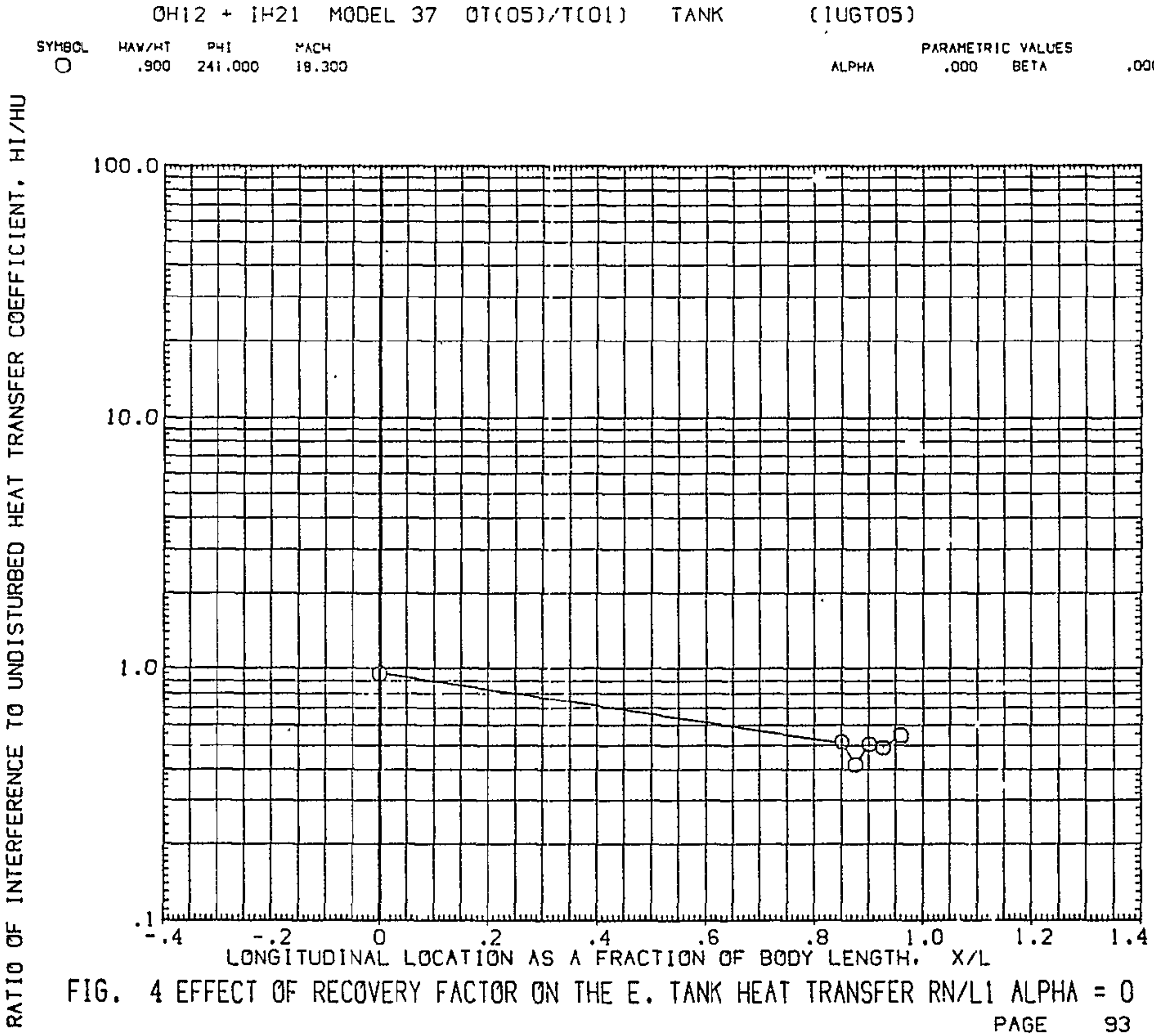

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

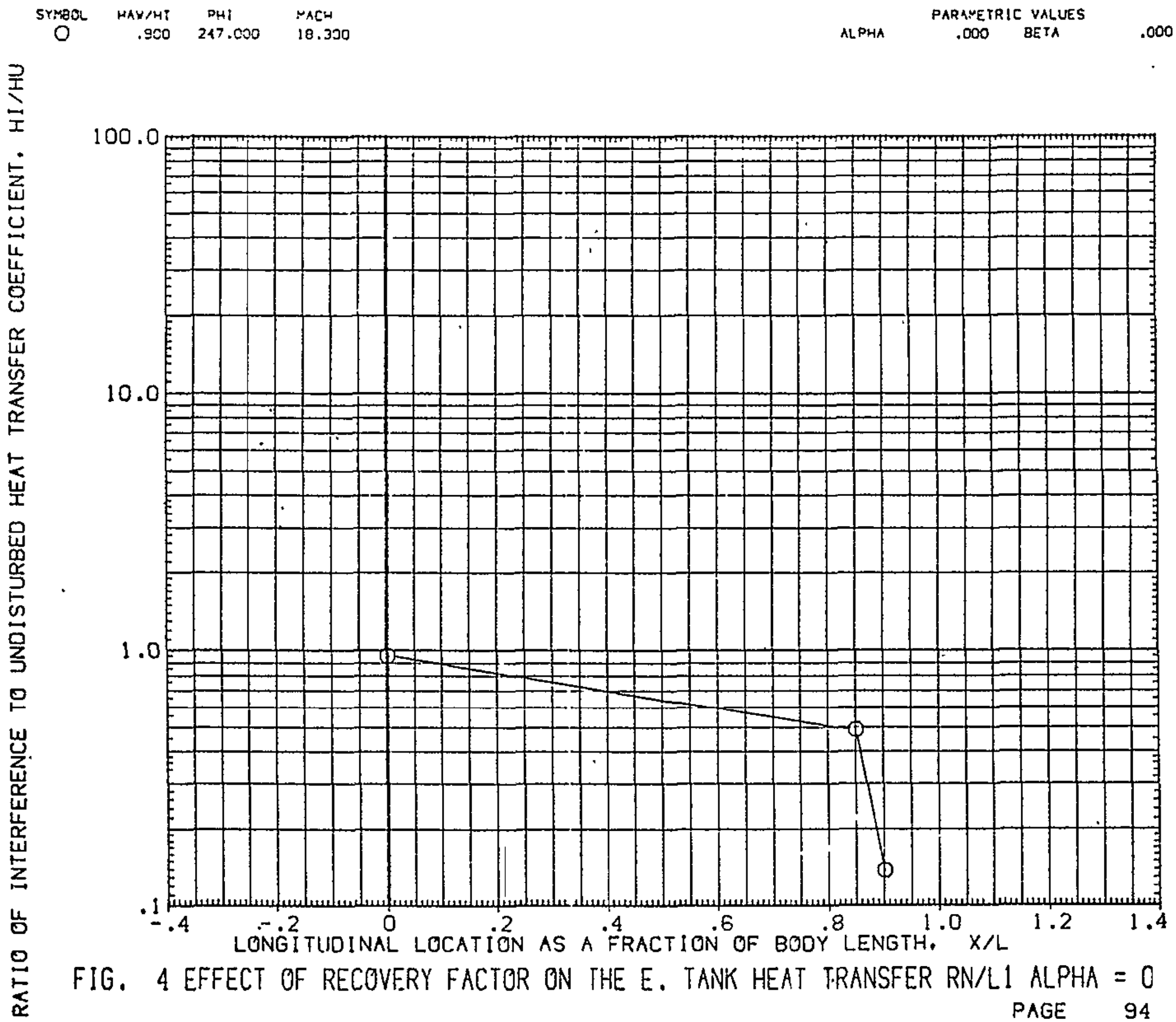

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

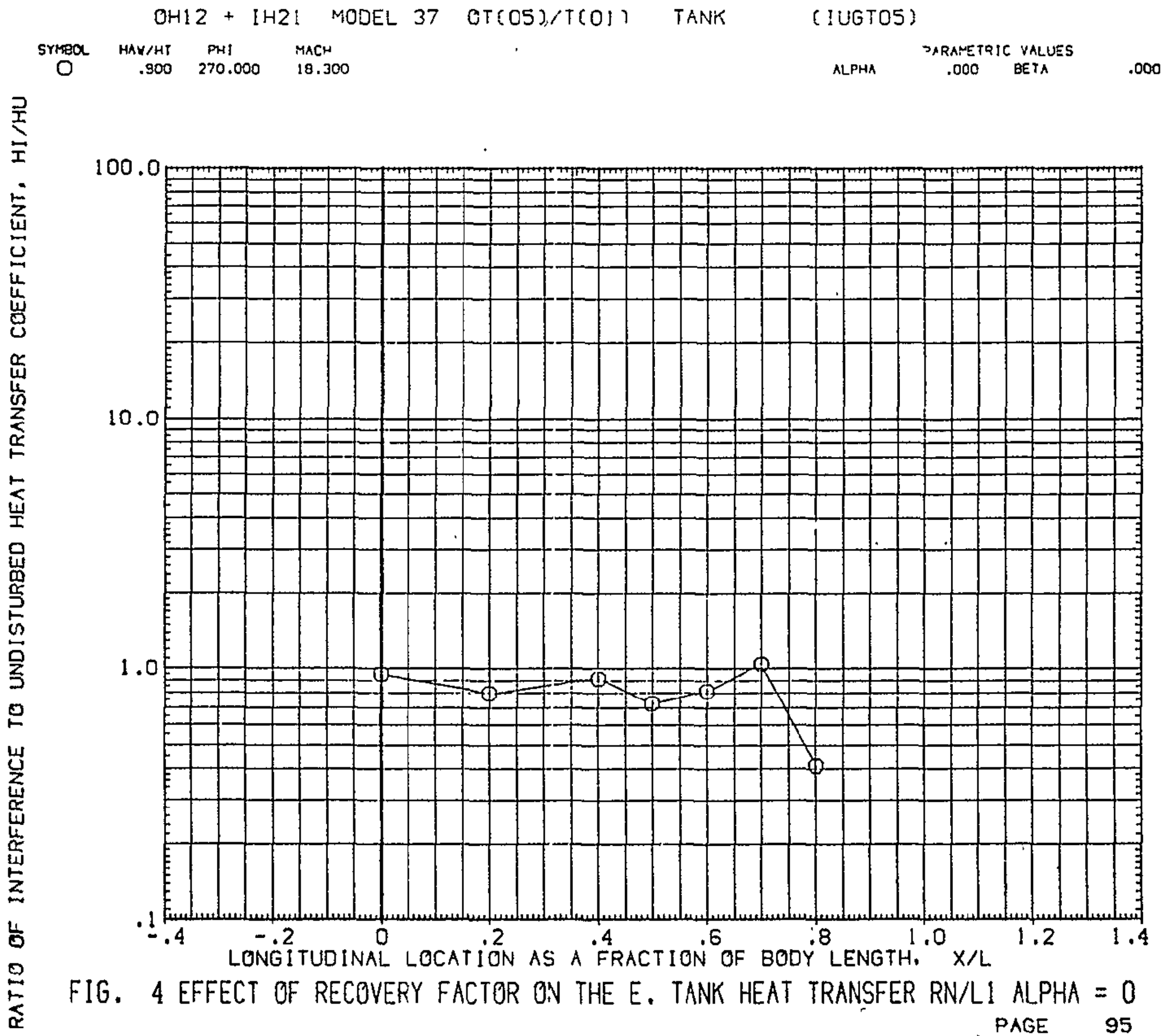

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH	PARAMETRIC VALUES			
O	.900	315.000	18.300	ALPHA	.000	BETA	.000

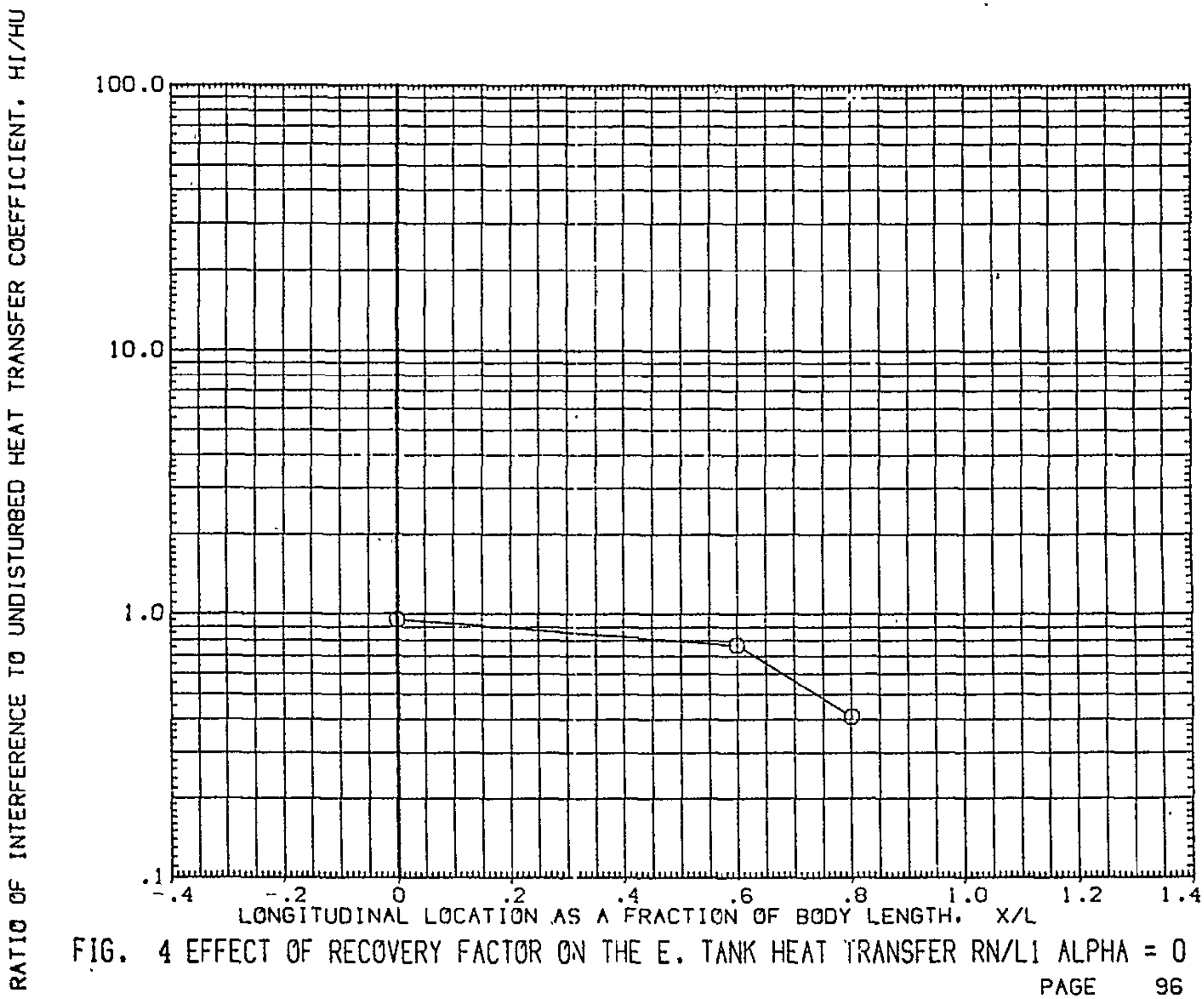

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0H12 + IH21 MODEL 37 0T(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	.000	19.160	ALPHA	.000	BETA	.000

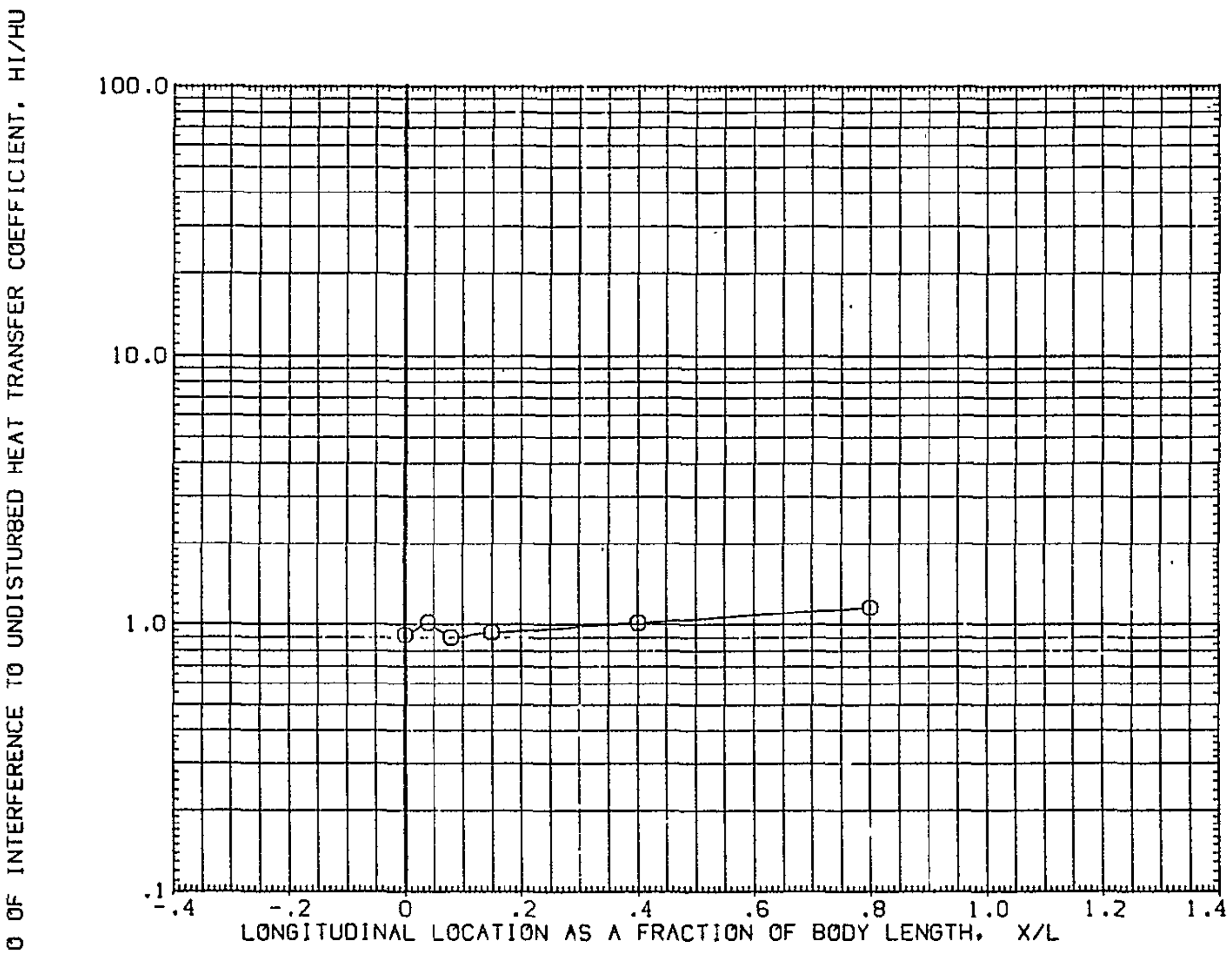

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

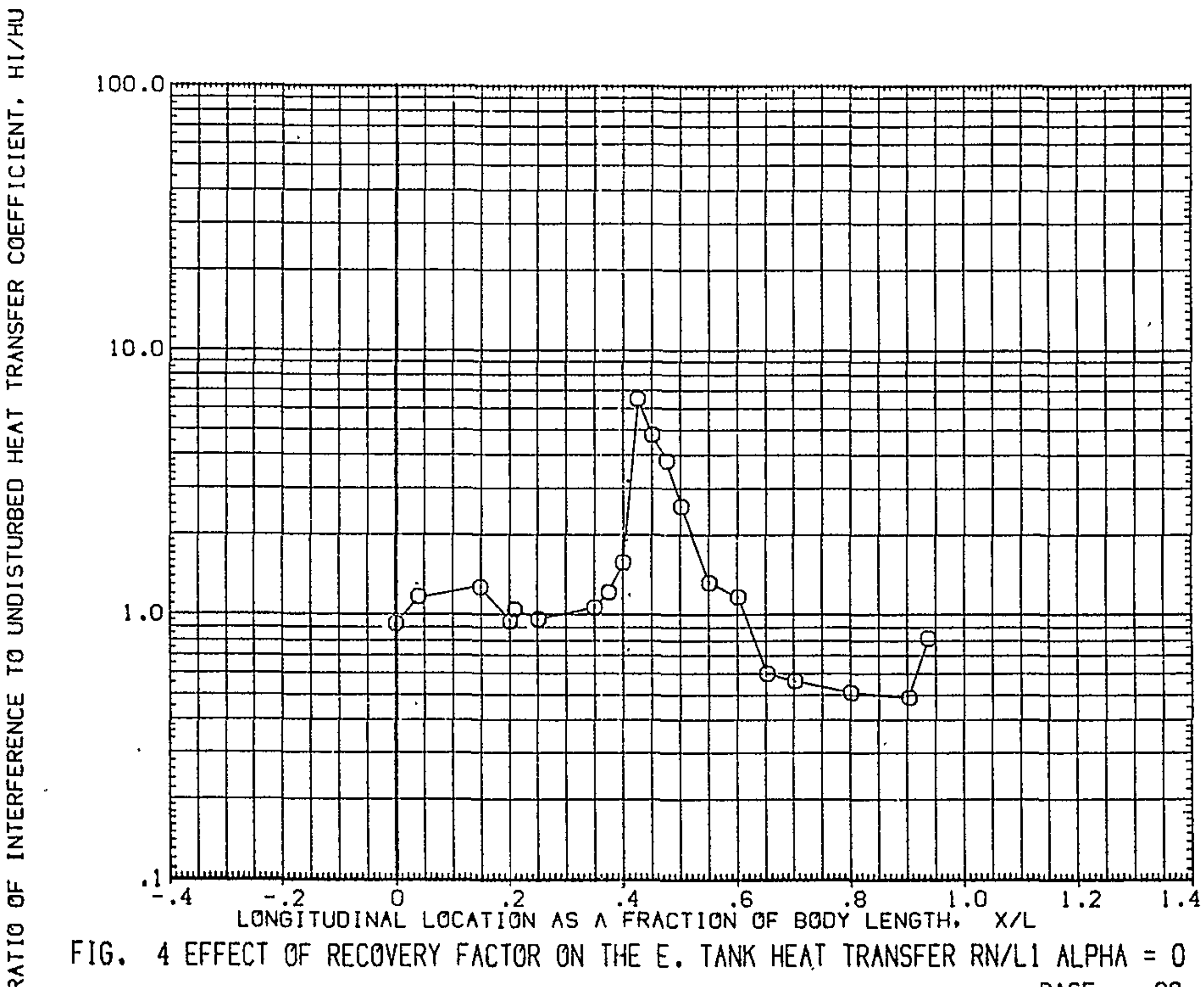

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0H12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	199.000	19.180	ALPHA	.000	BETA	.000

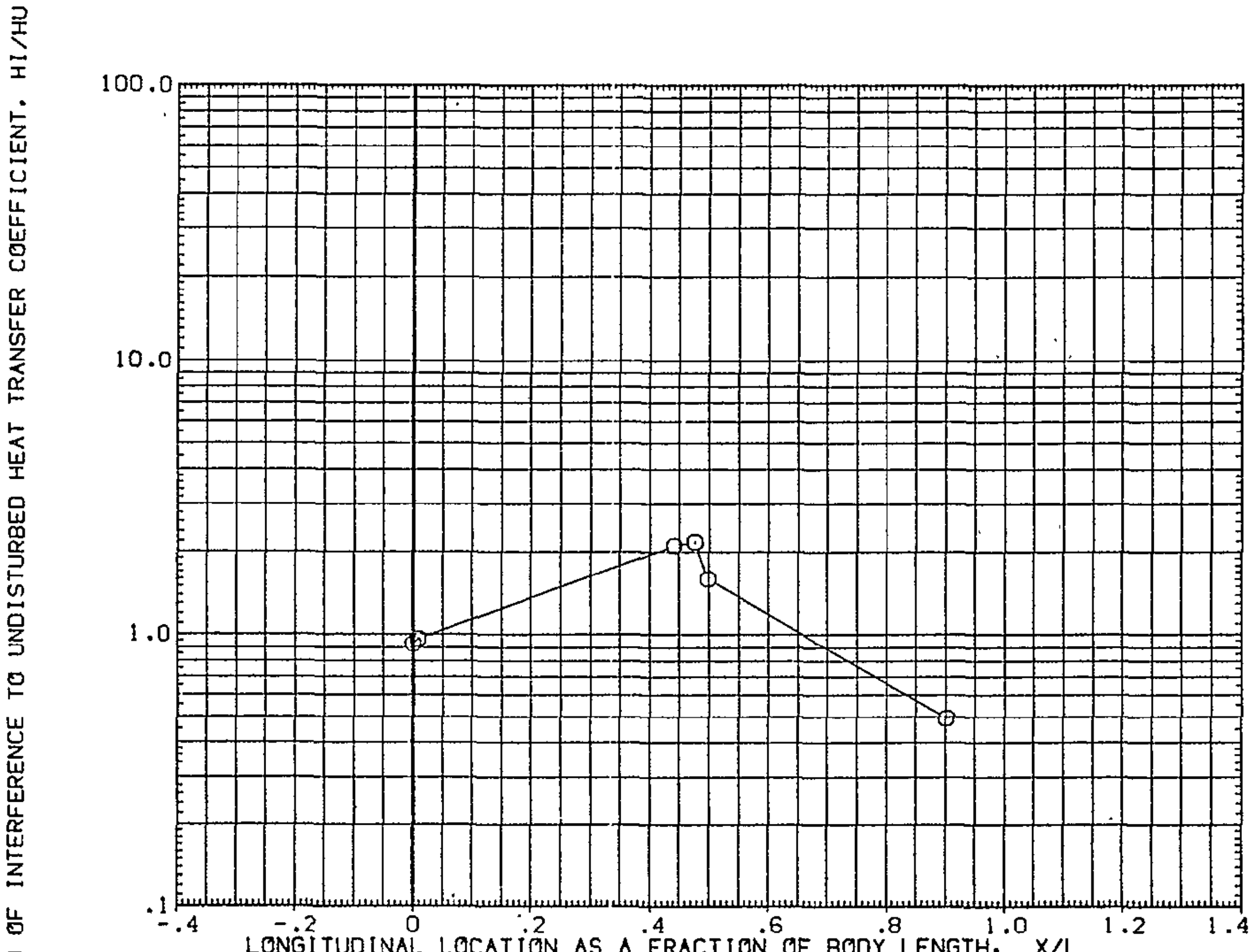

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

SYMBOL O HAW/HT .900 PHI 221.000 MACH 19.180

PARAMETRIC VALUES ALPHA .000 BETA .000

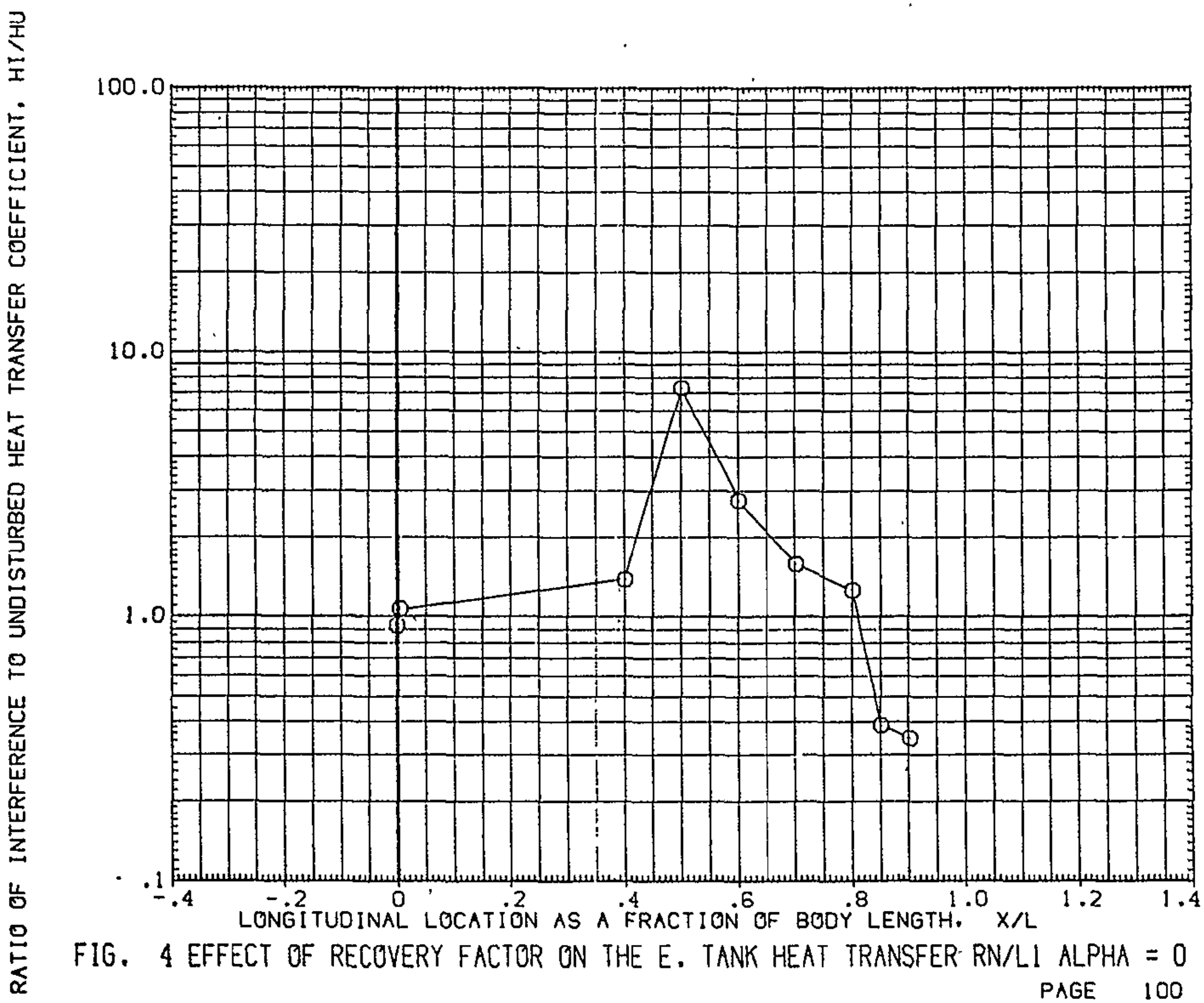

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0HI2 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

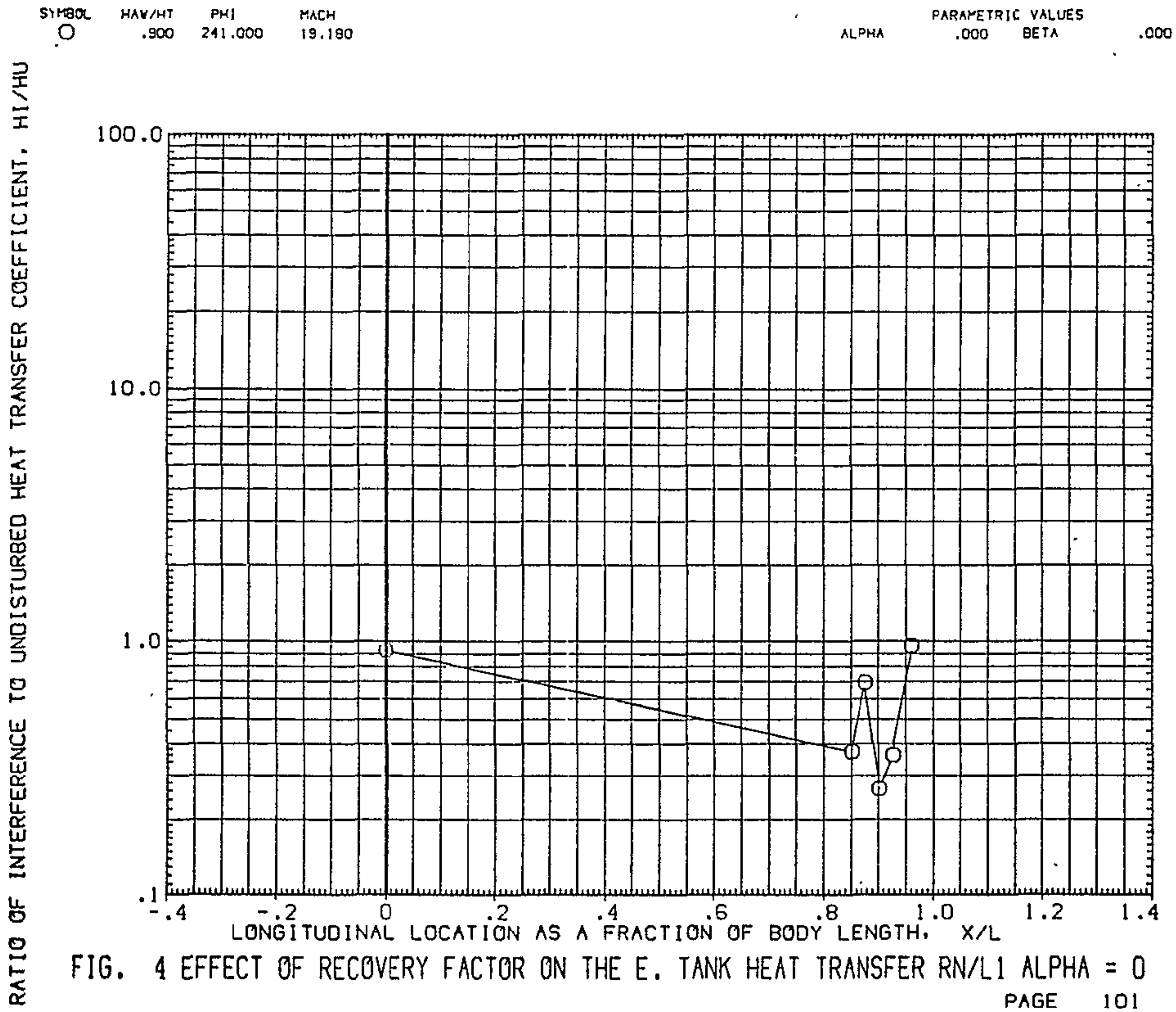

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

0H12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

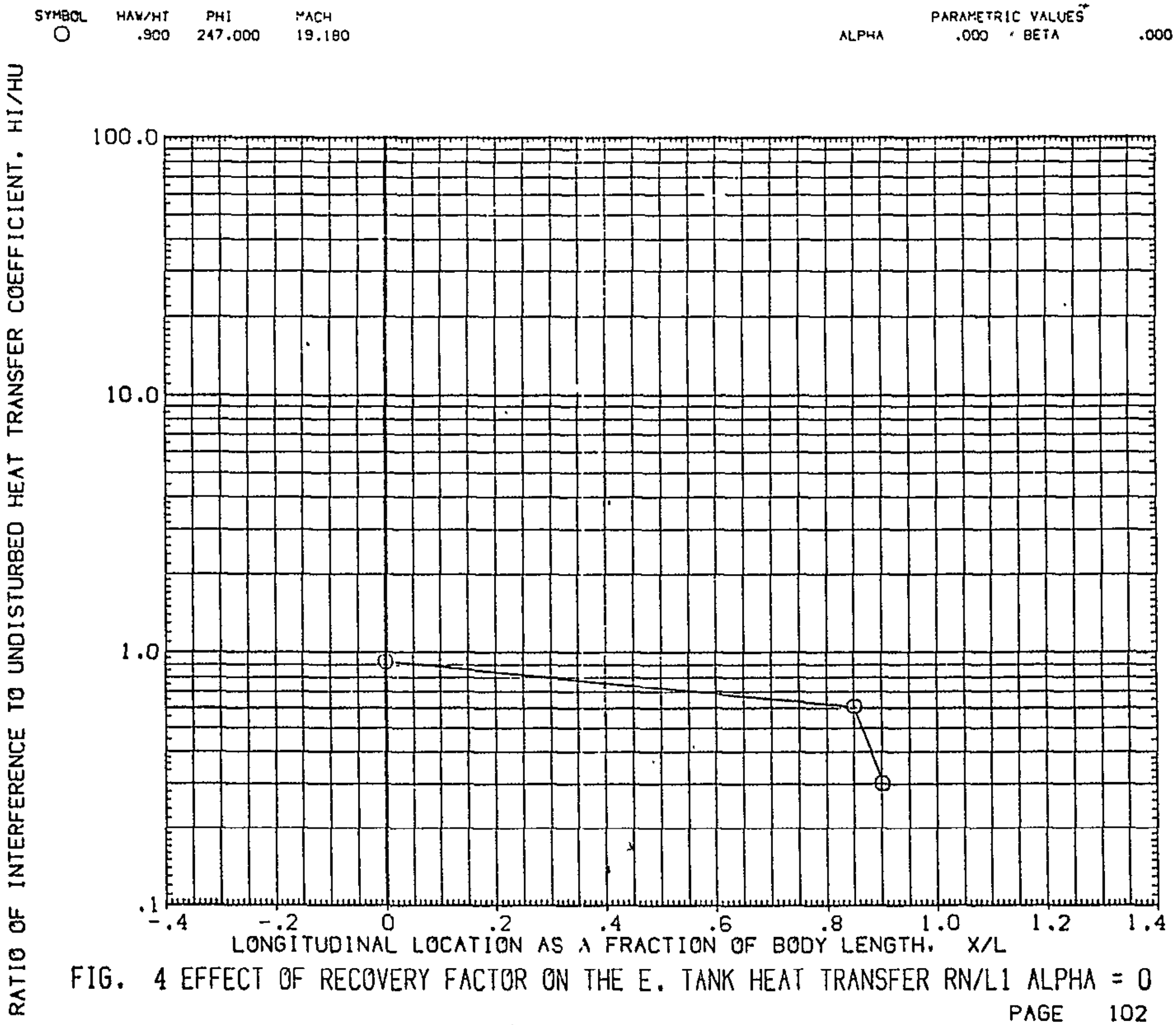

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

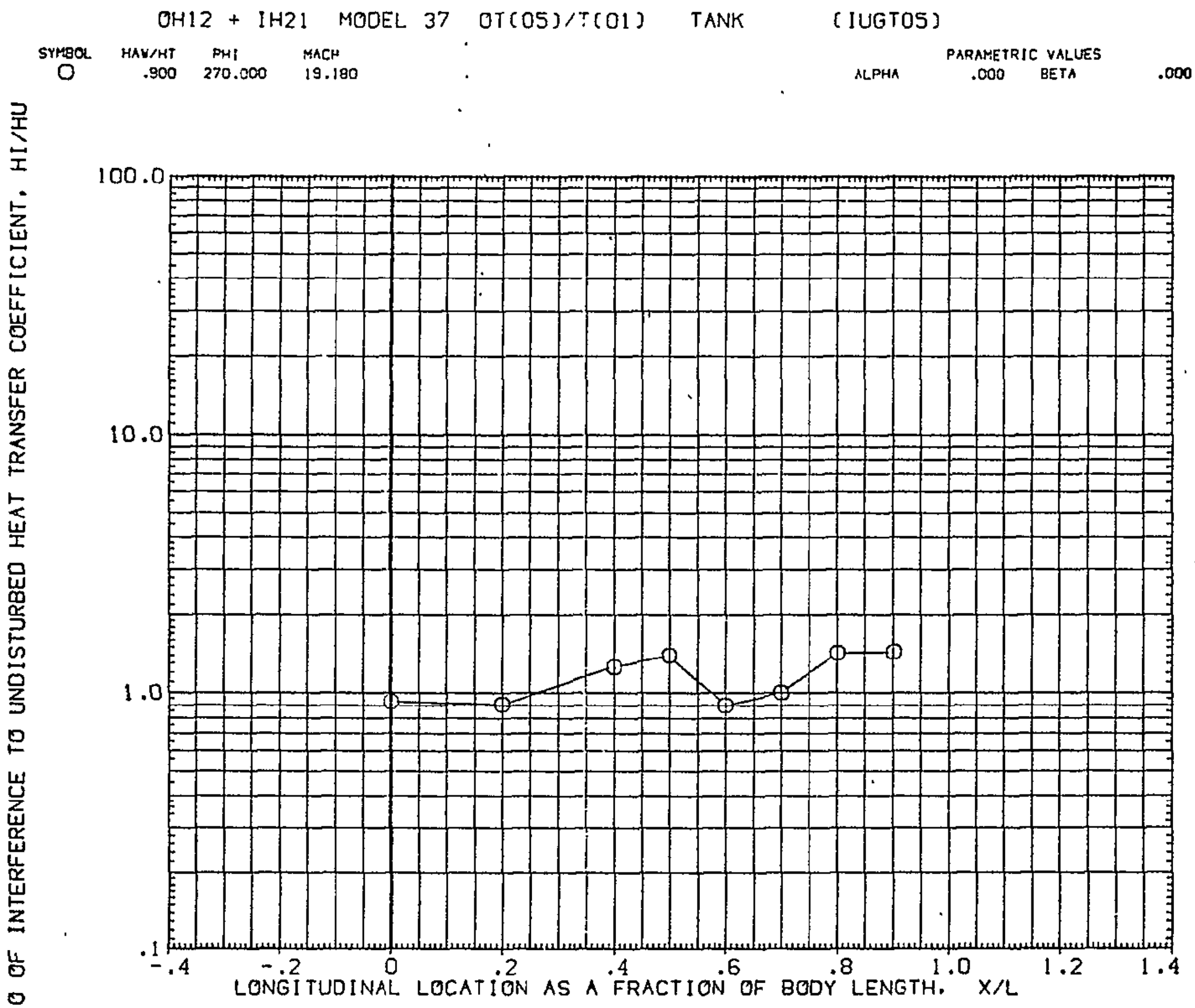

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/T(01) TANK (IUGT05)

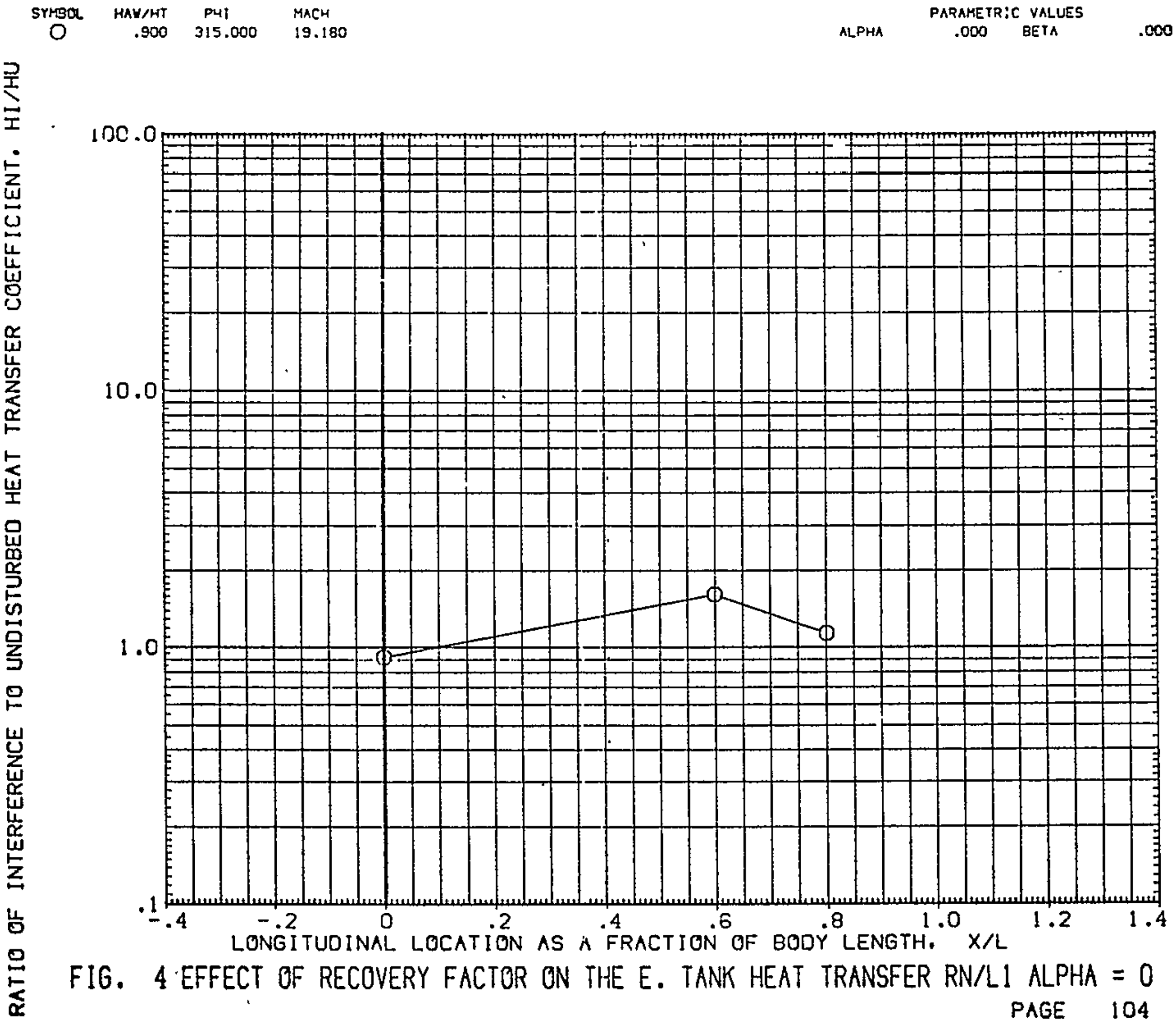

FIG. 4 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L1 ALPHA = 0

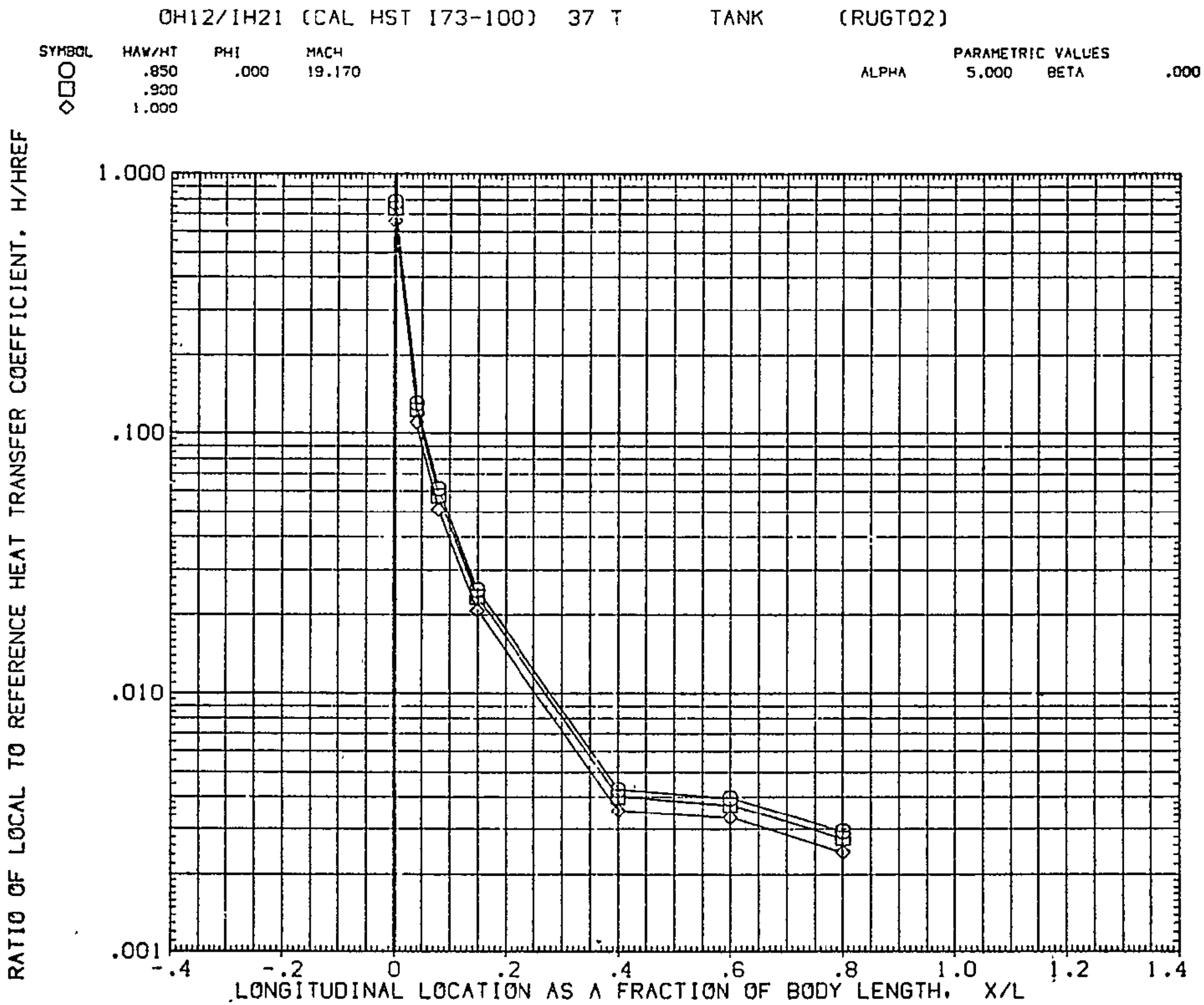

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

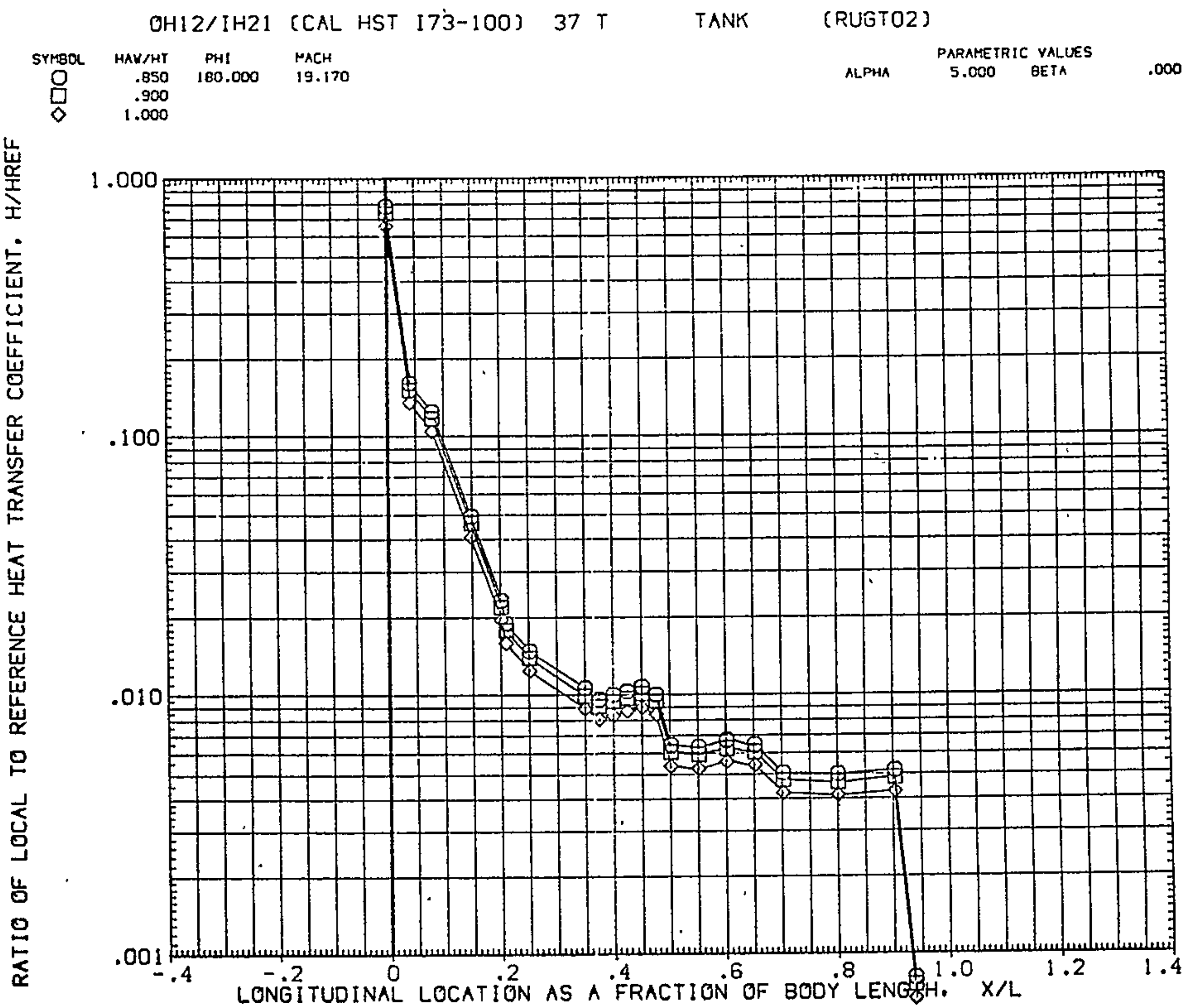

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

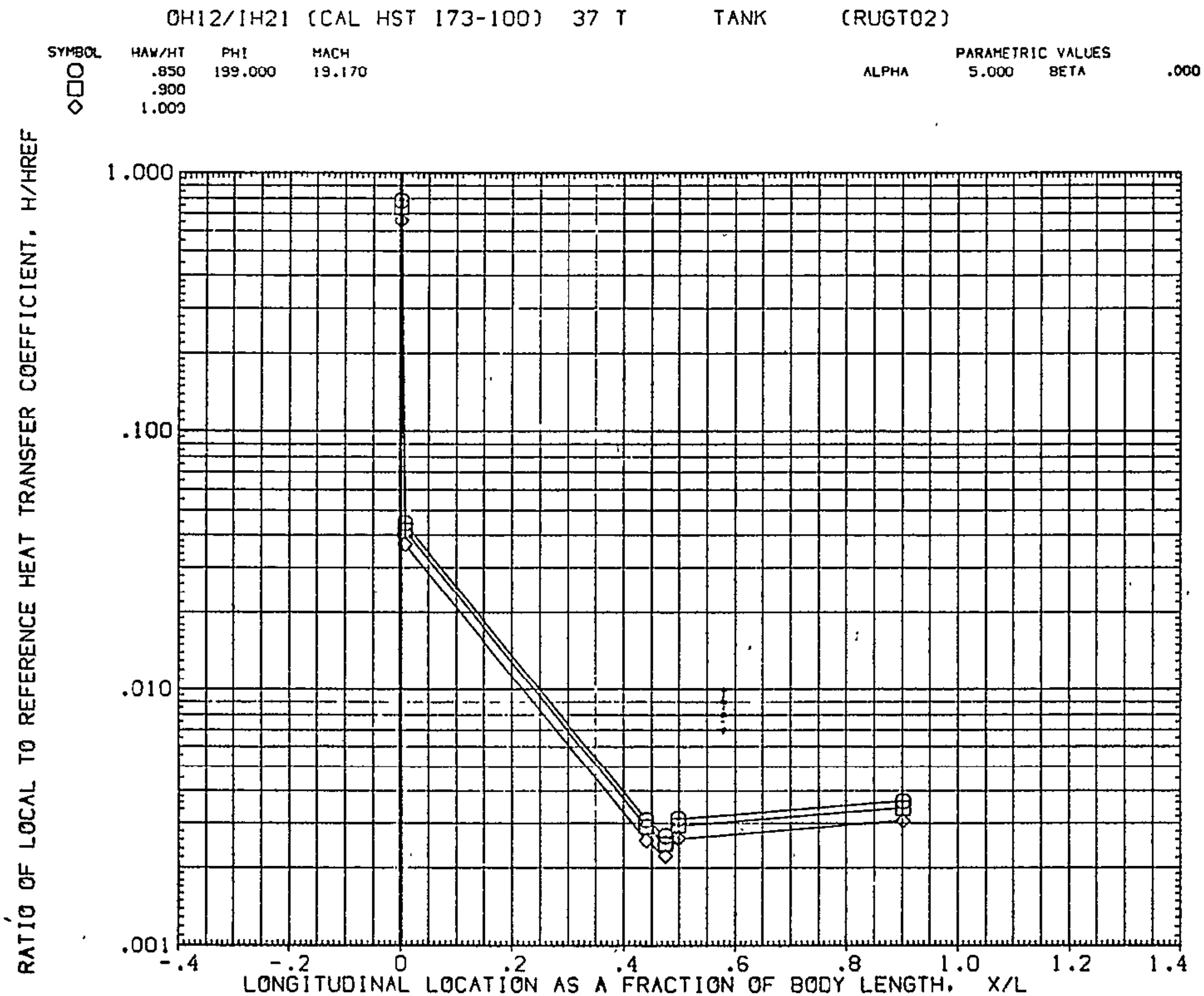

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

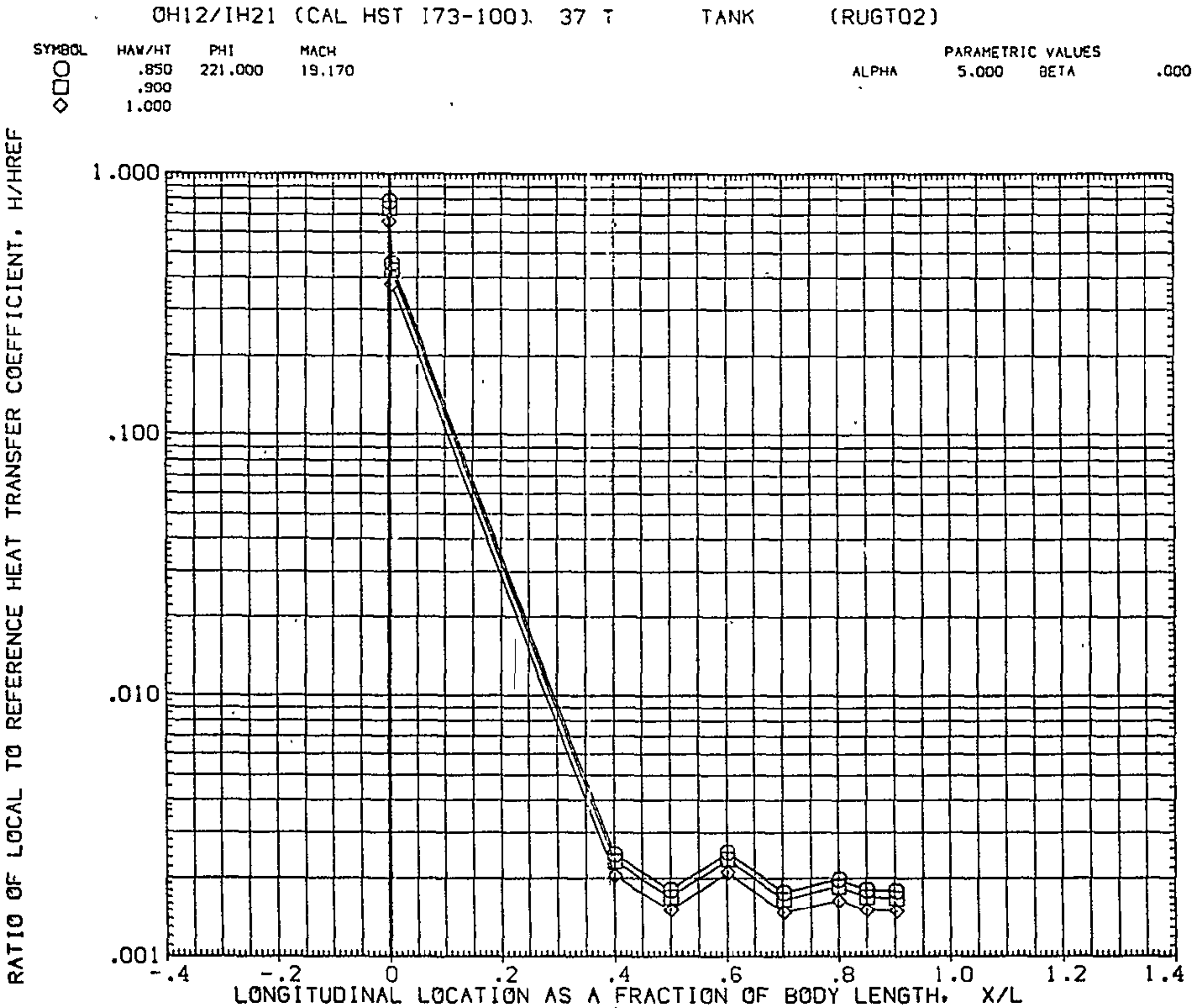

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

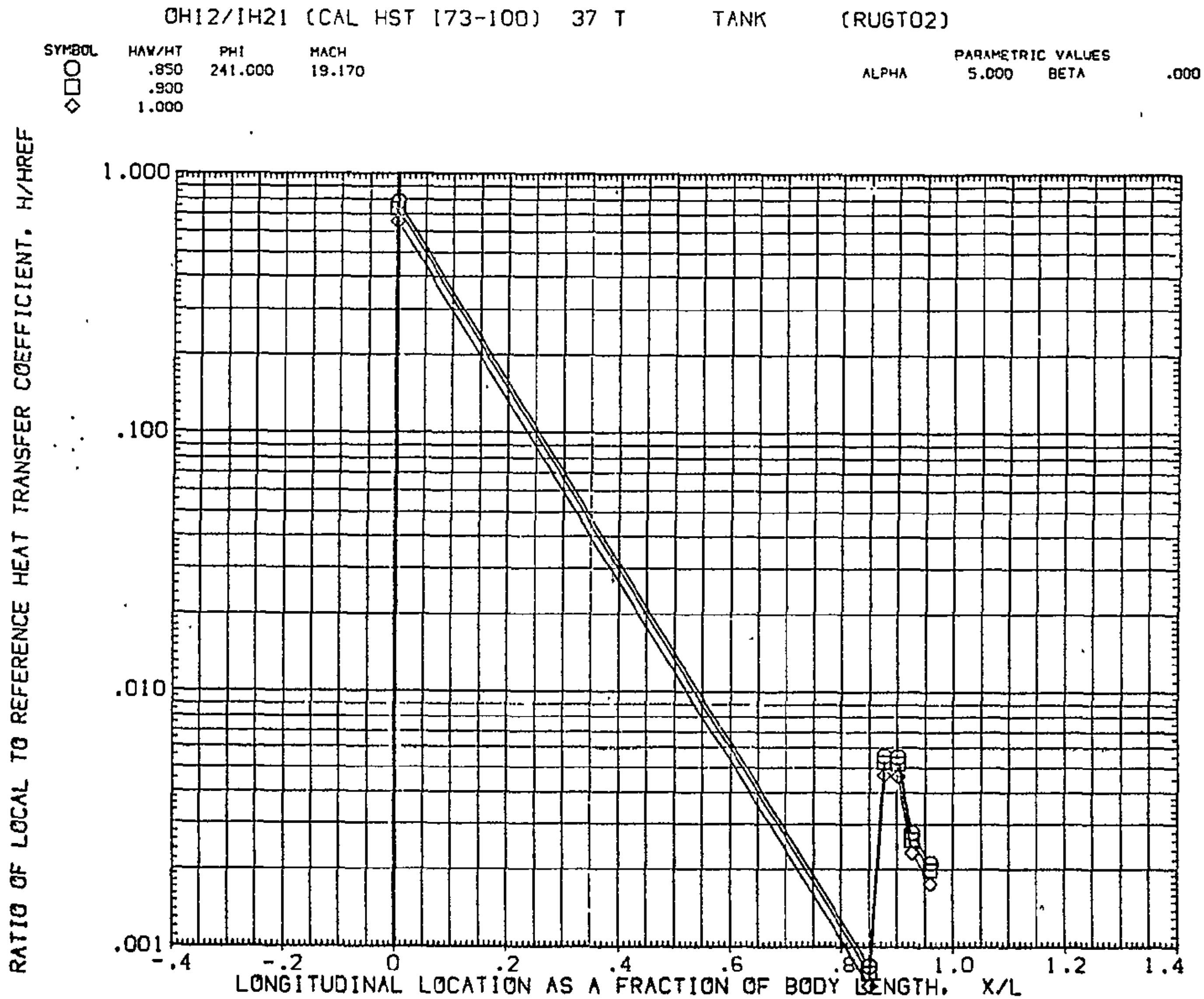

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

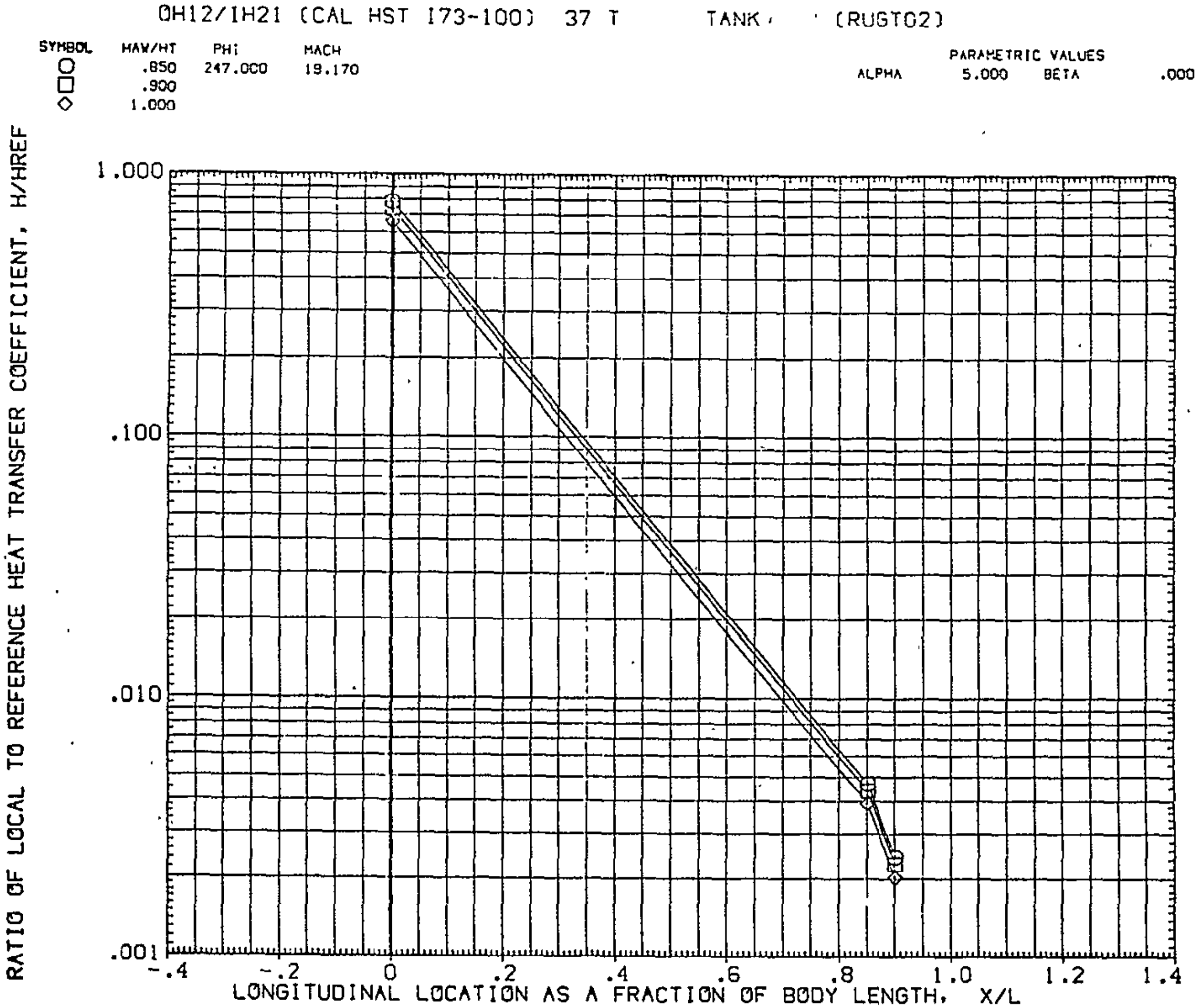

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

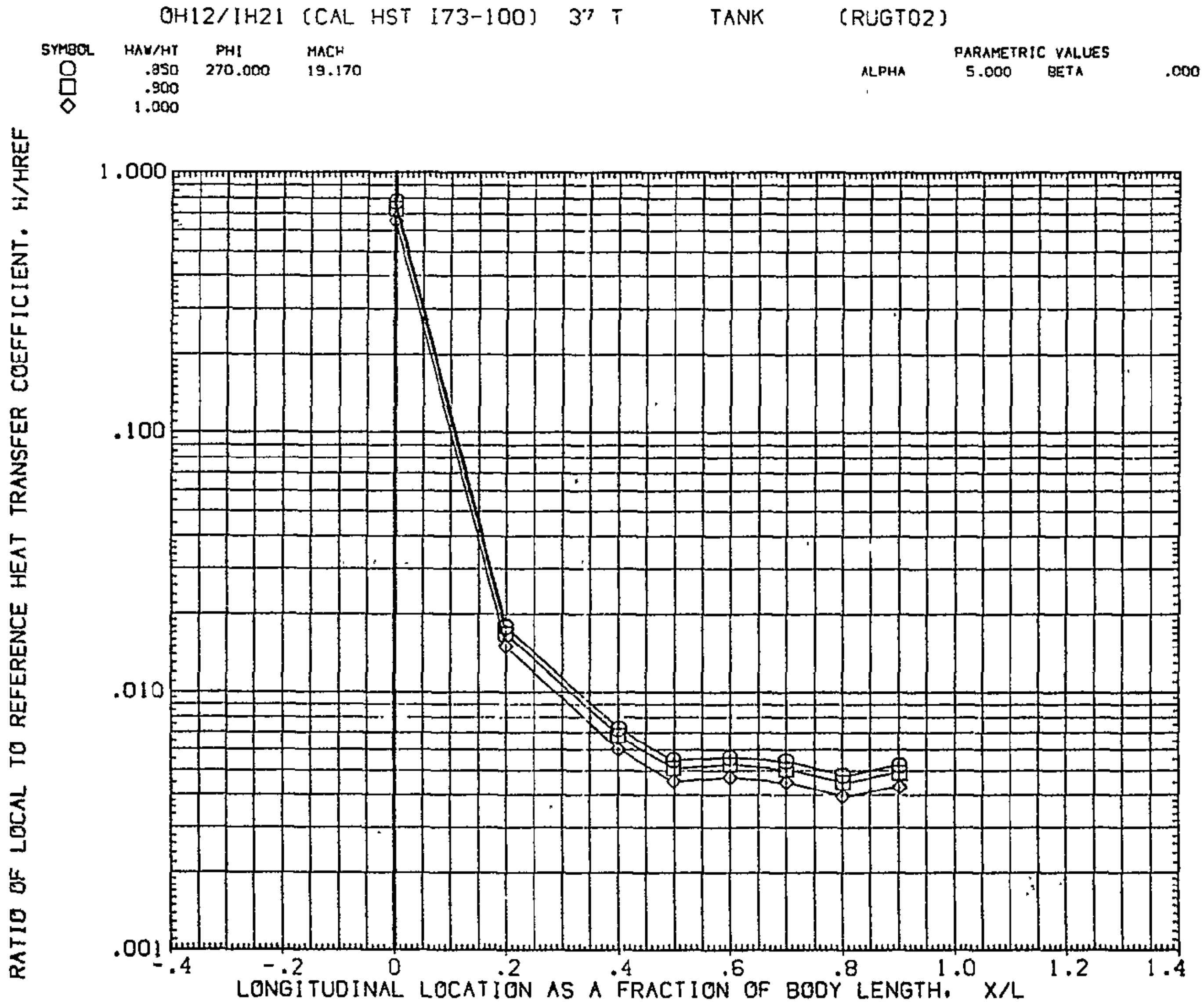

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

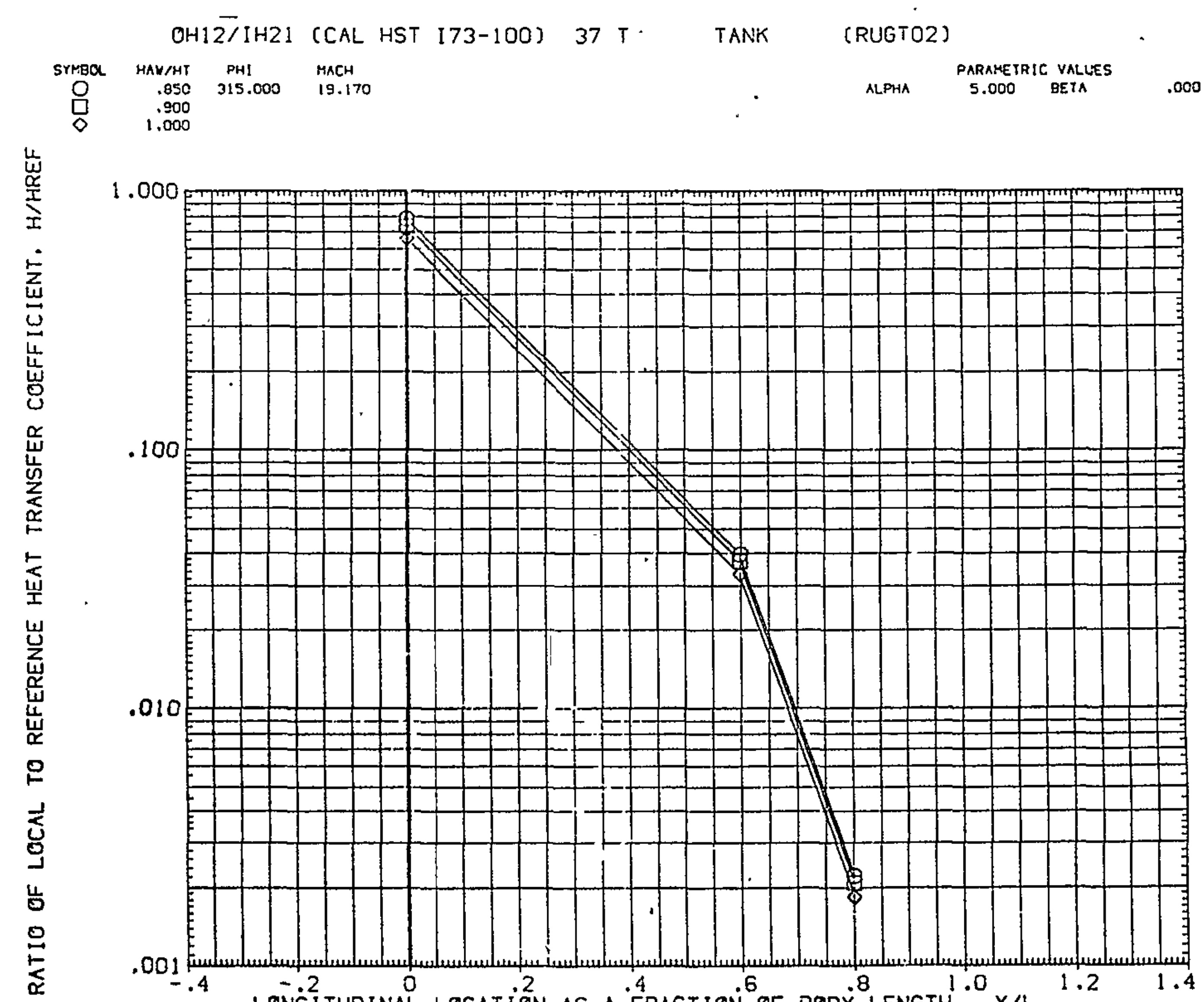

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

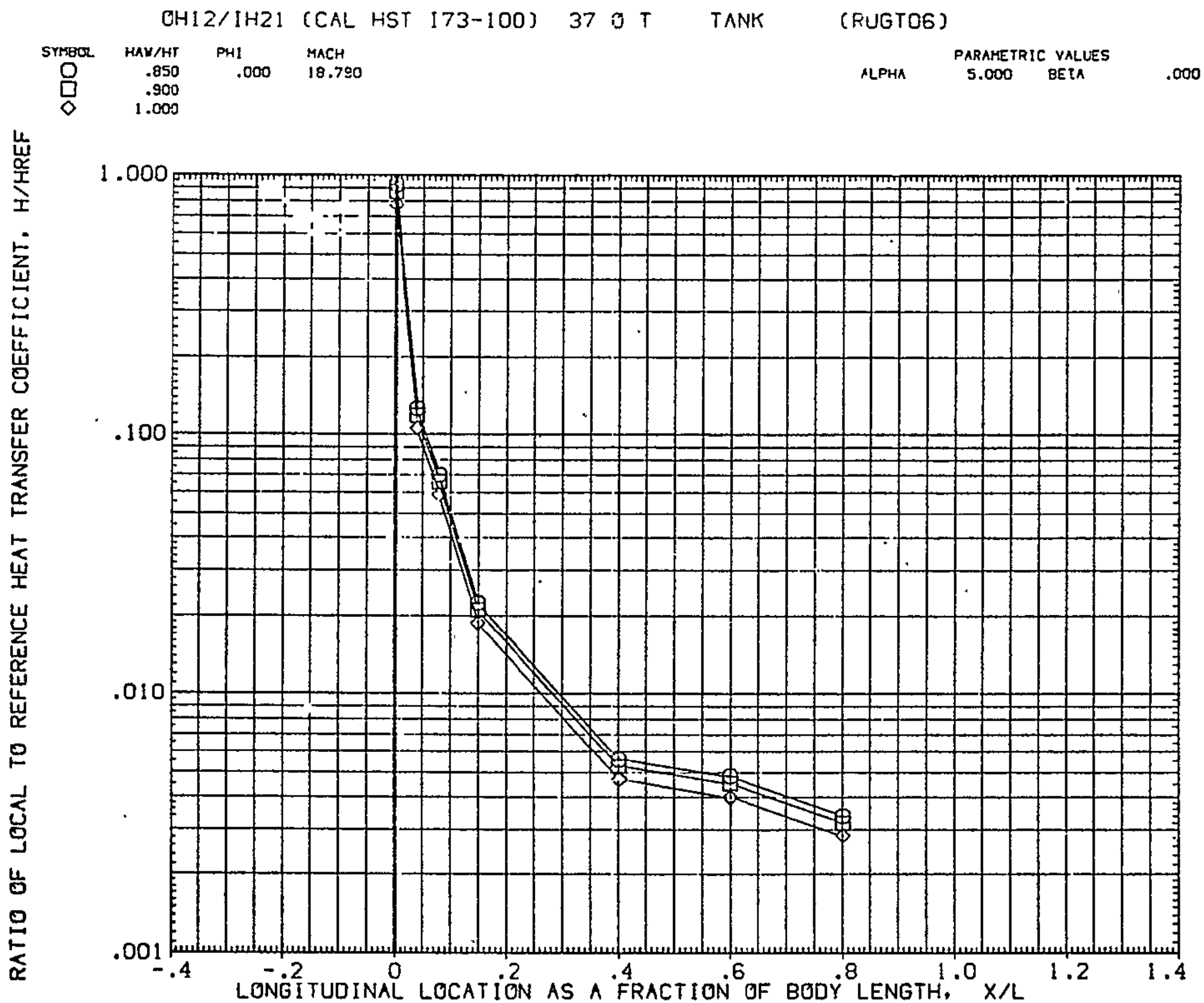

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

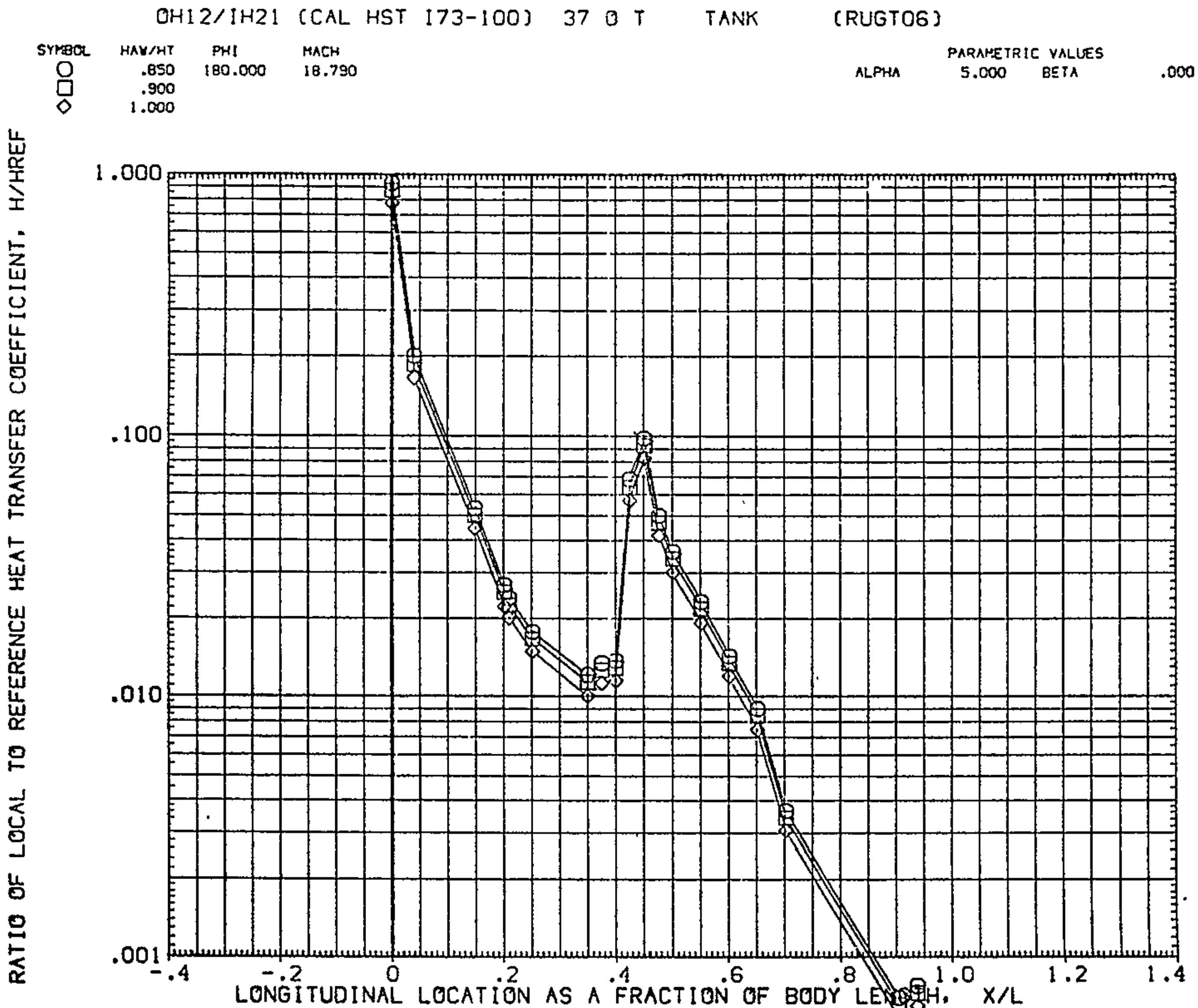

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

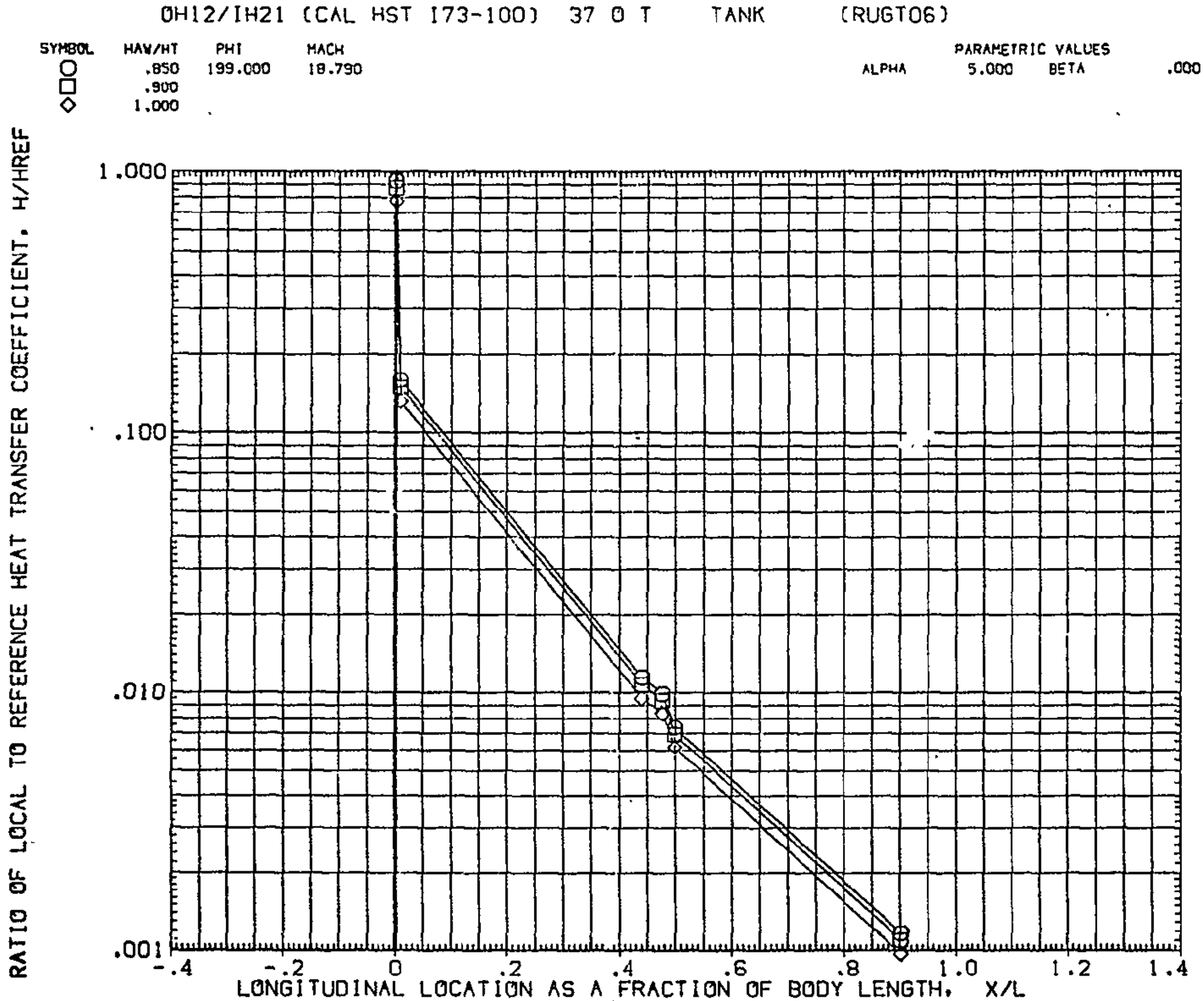

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

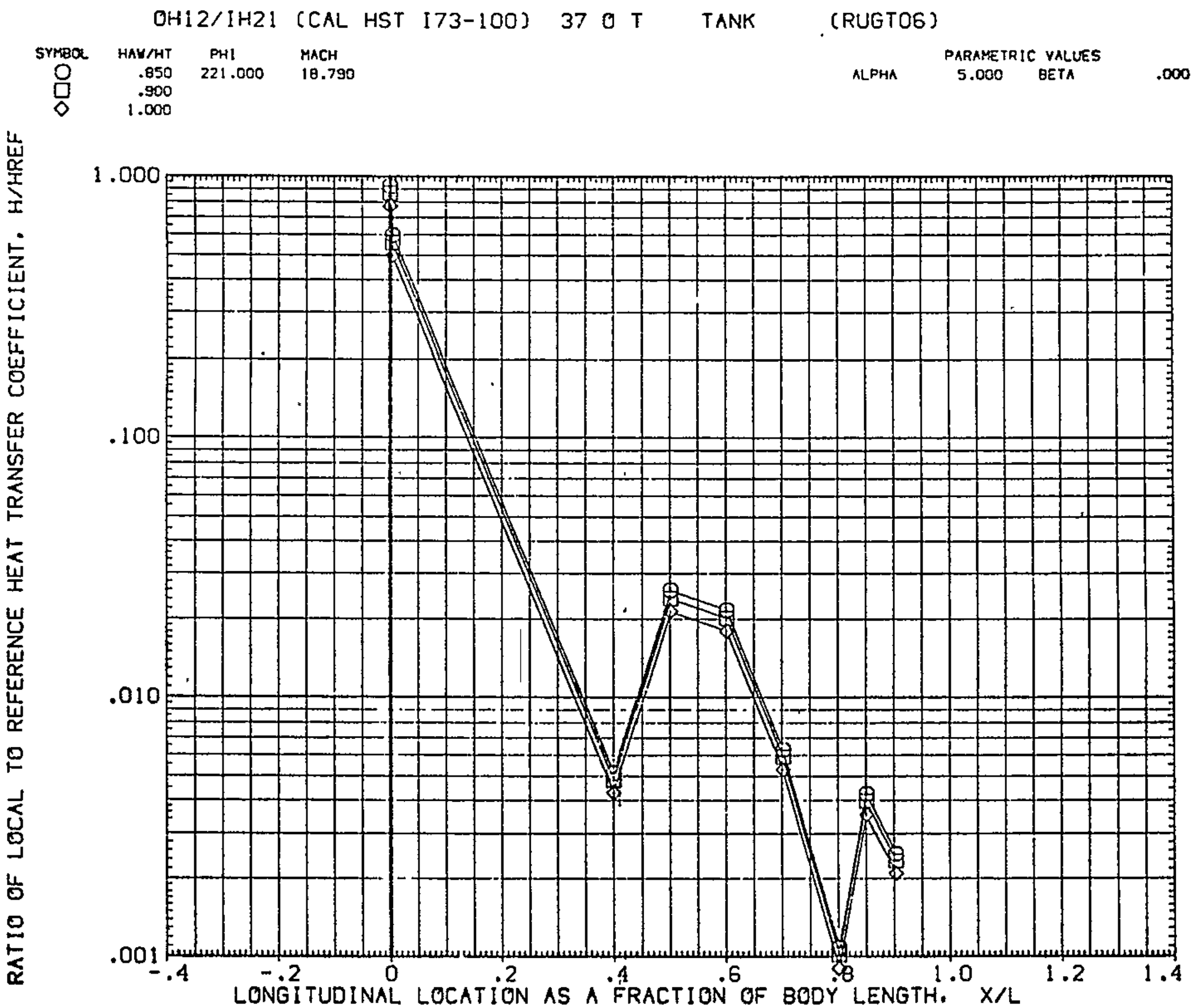

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

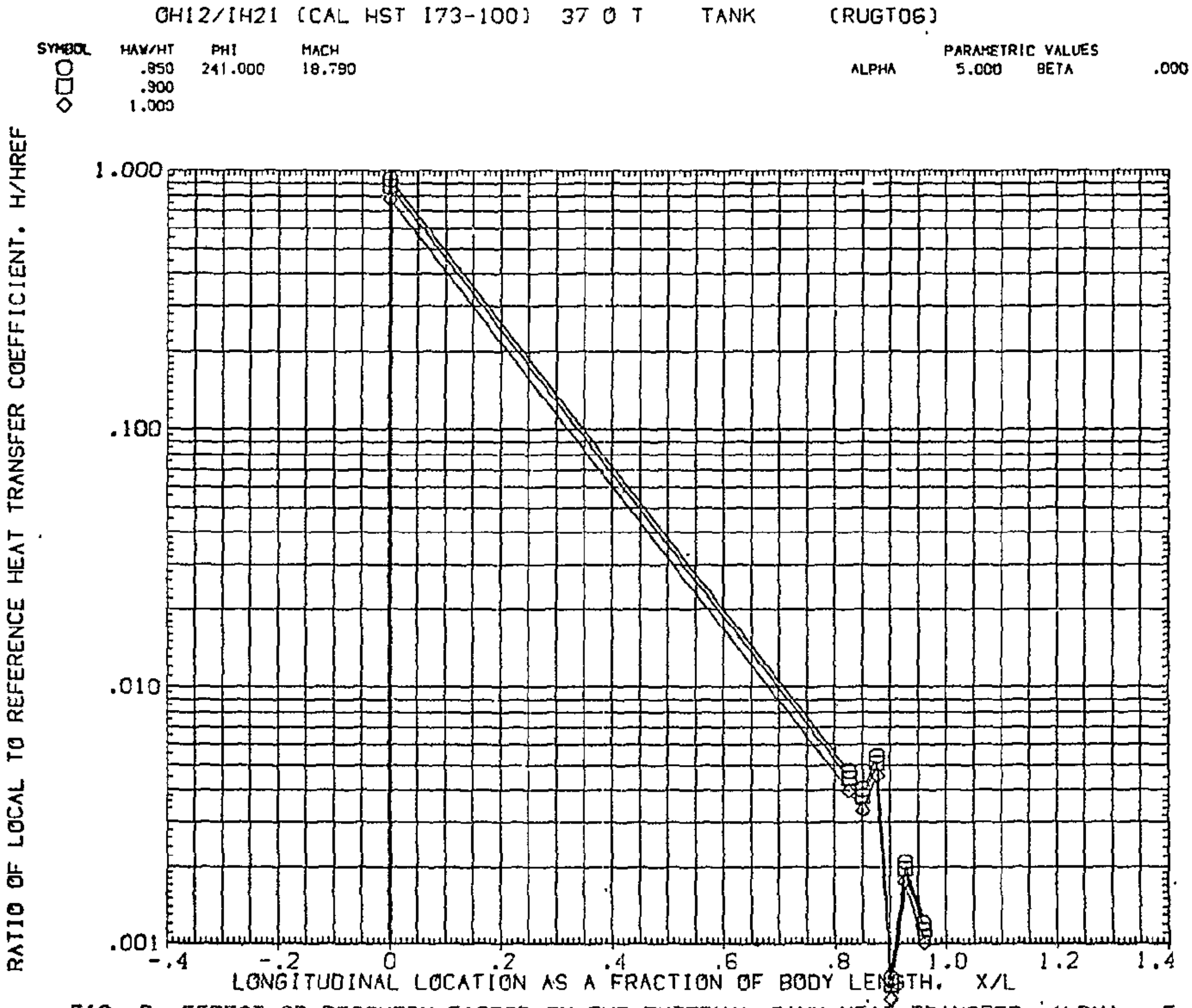

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

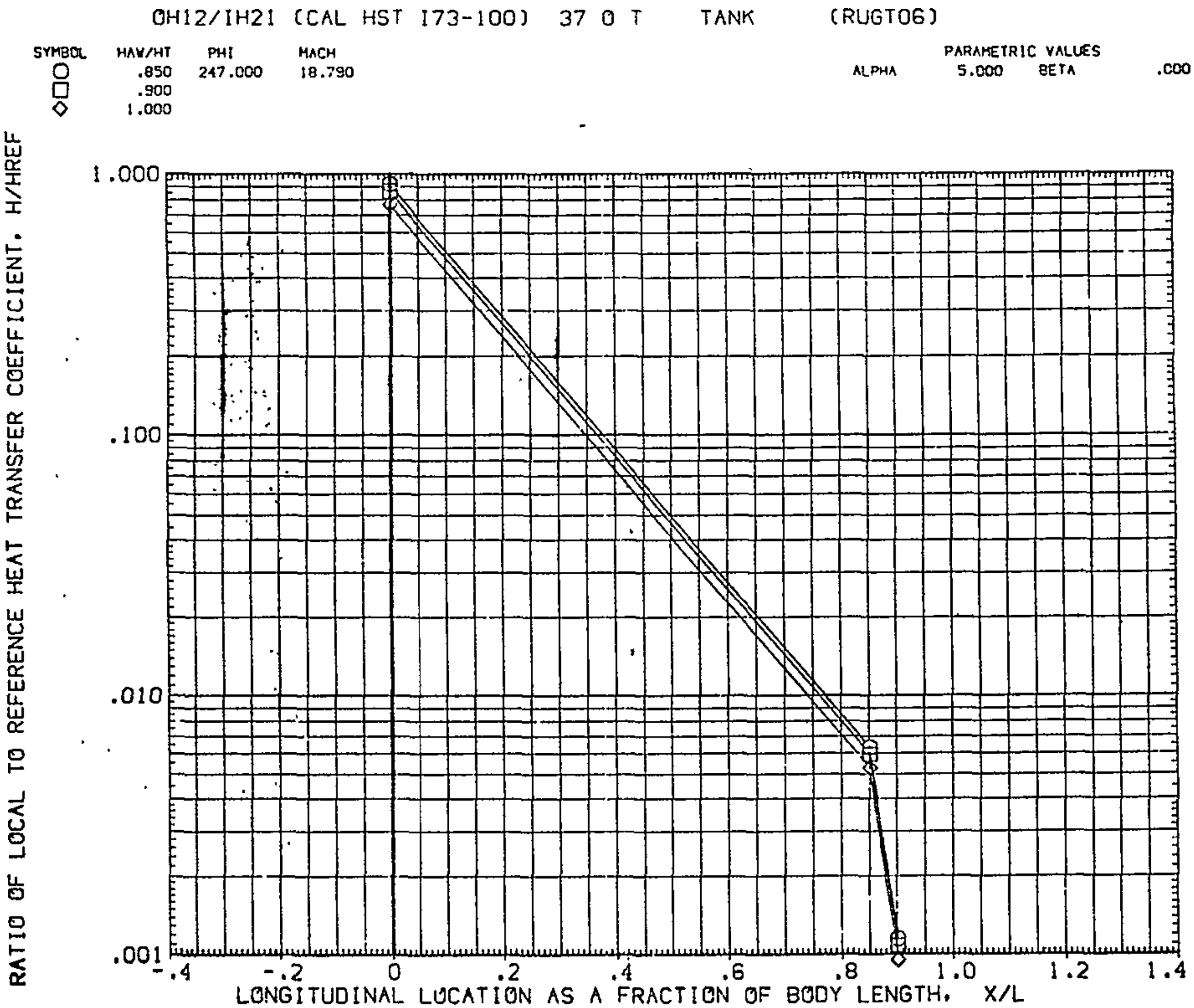

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

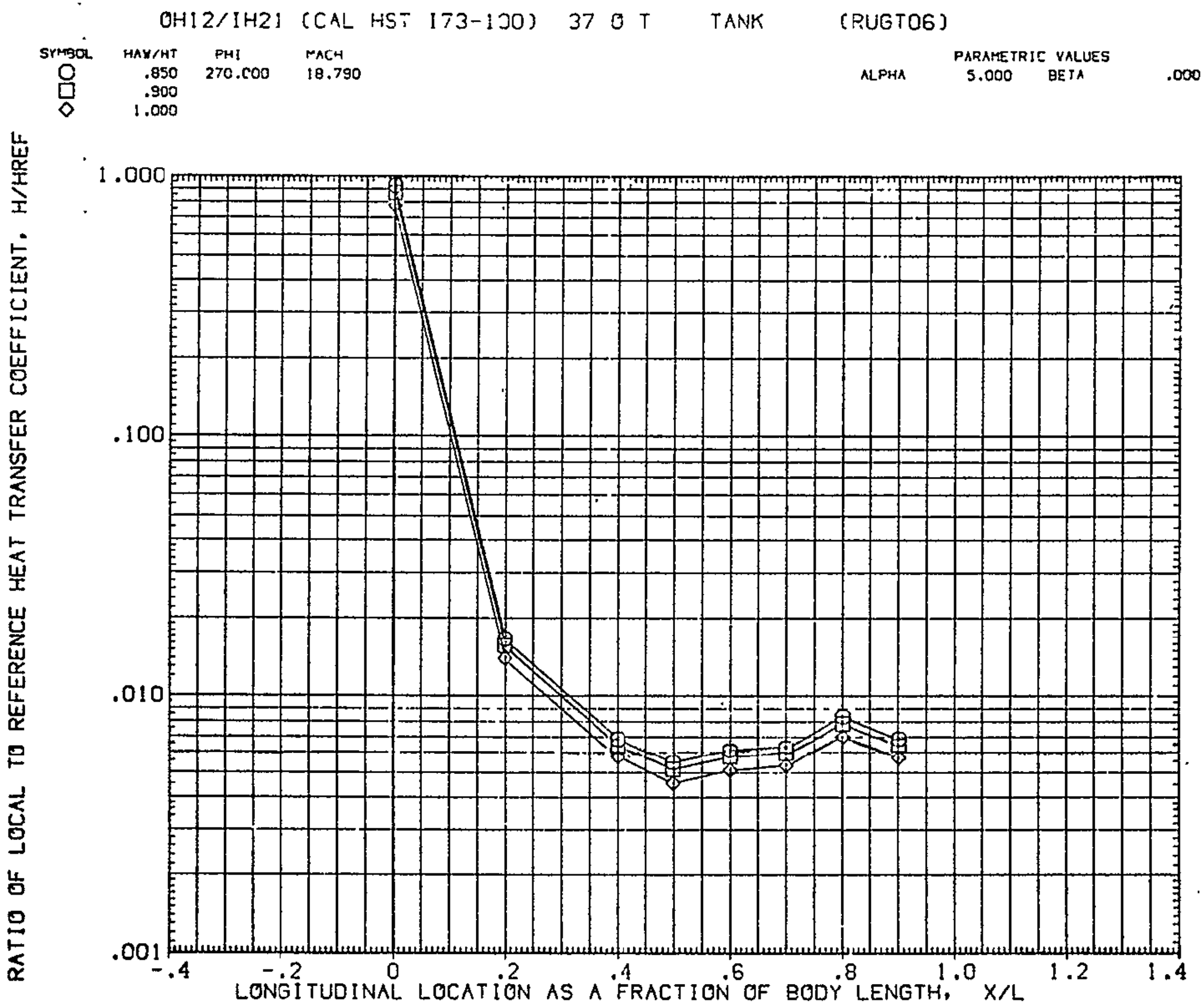

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

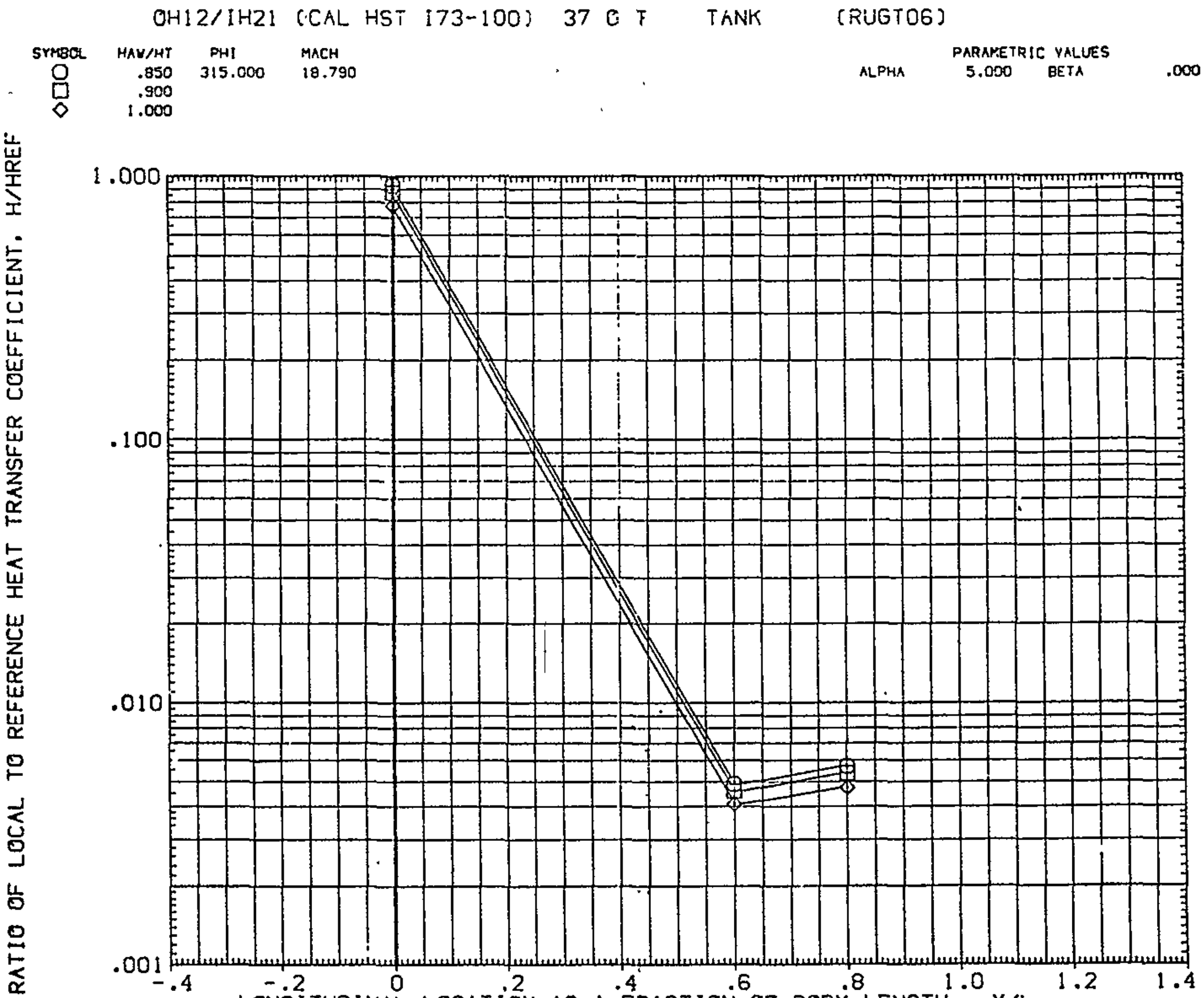

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

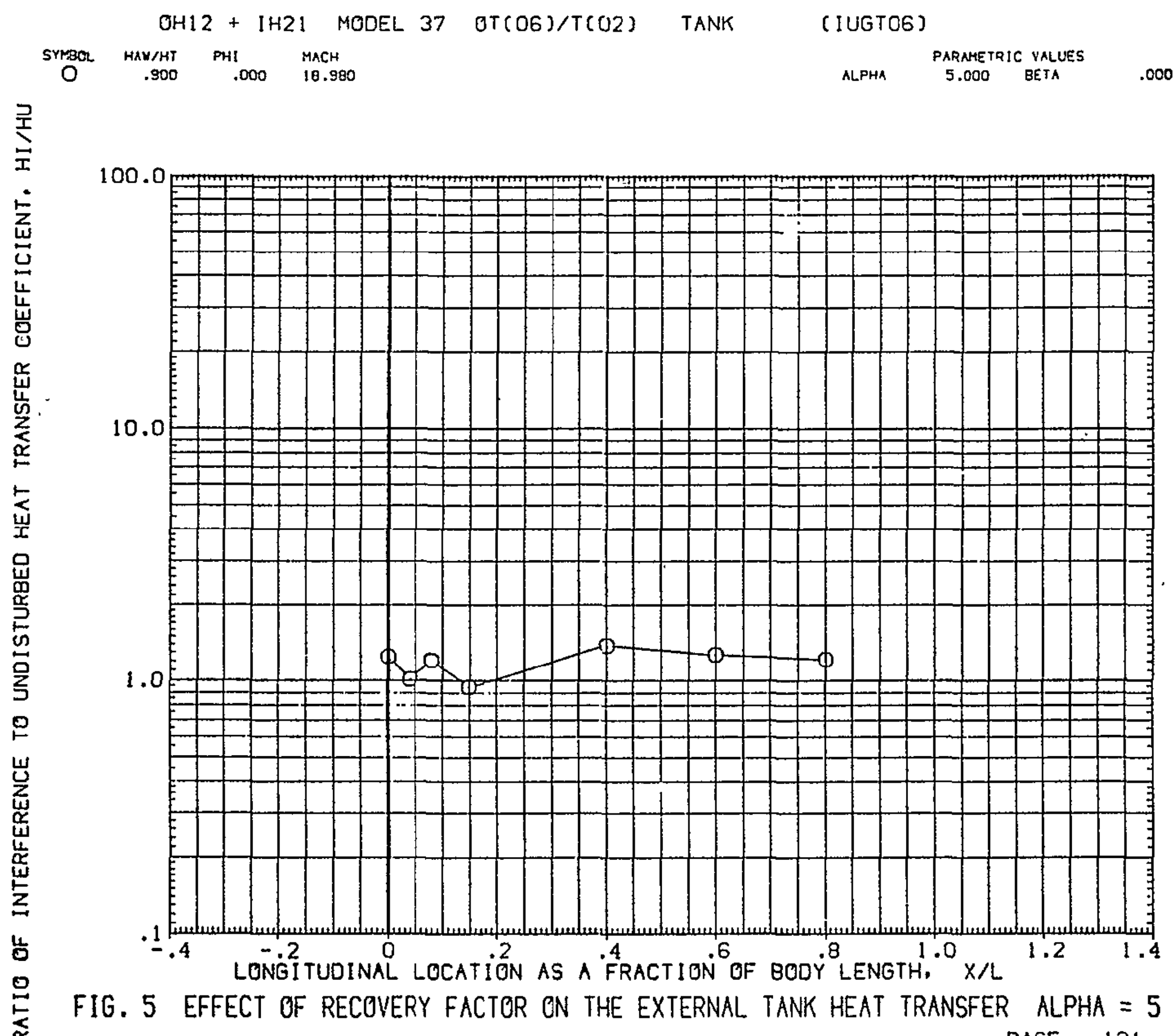

FIG. 5 EFFECT ØF RECØVERY FACTØR ØN THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

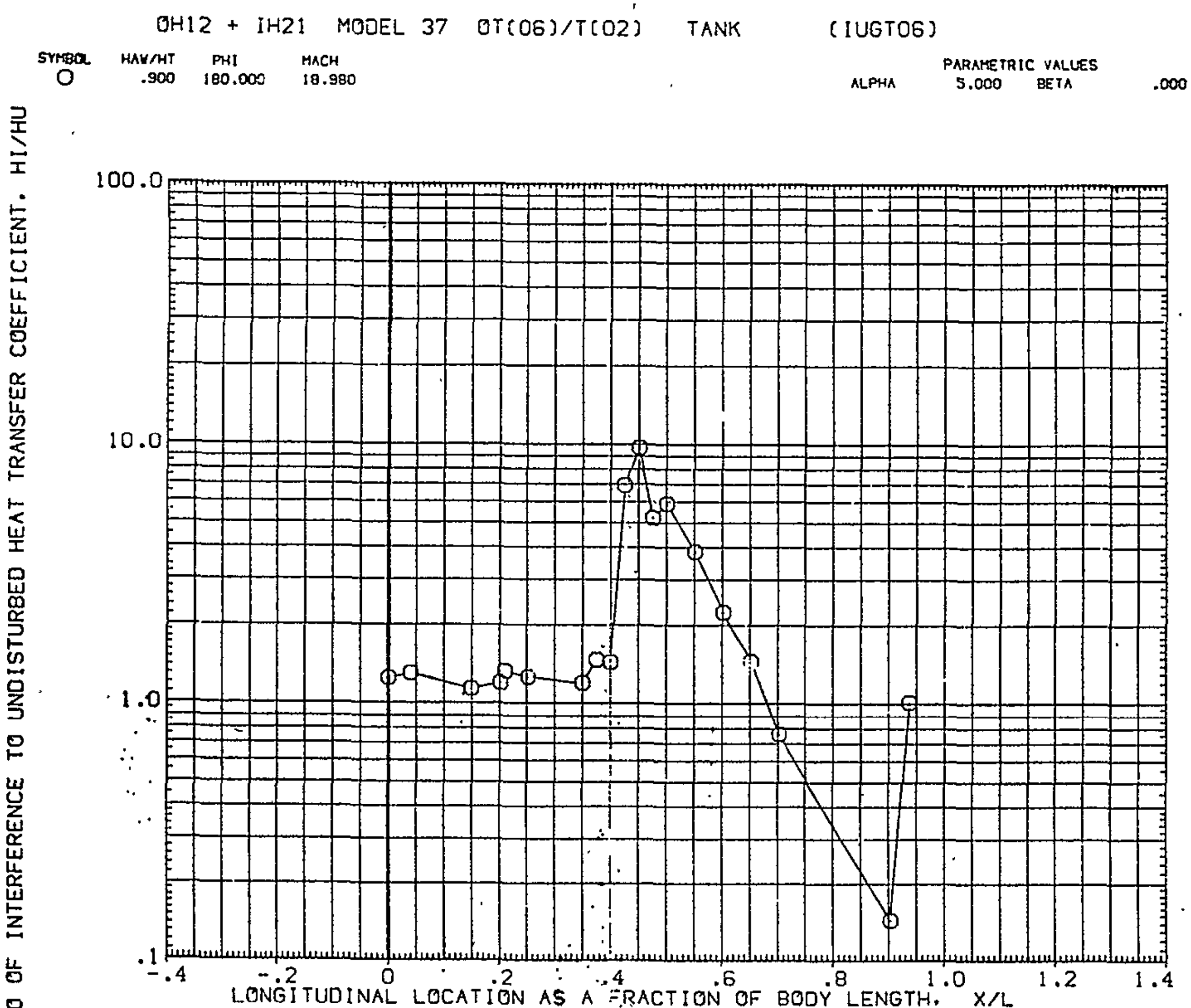

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/T(02) TANK (IUGT06)

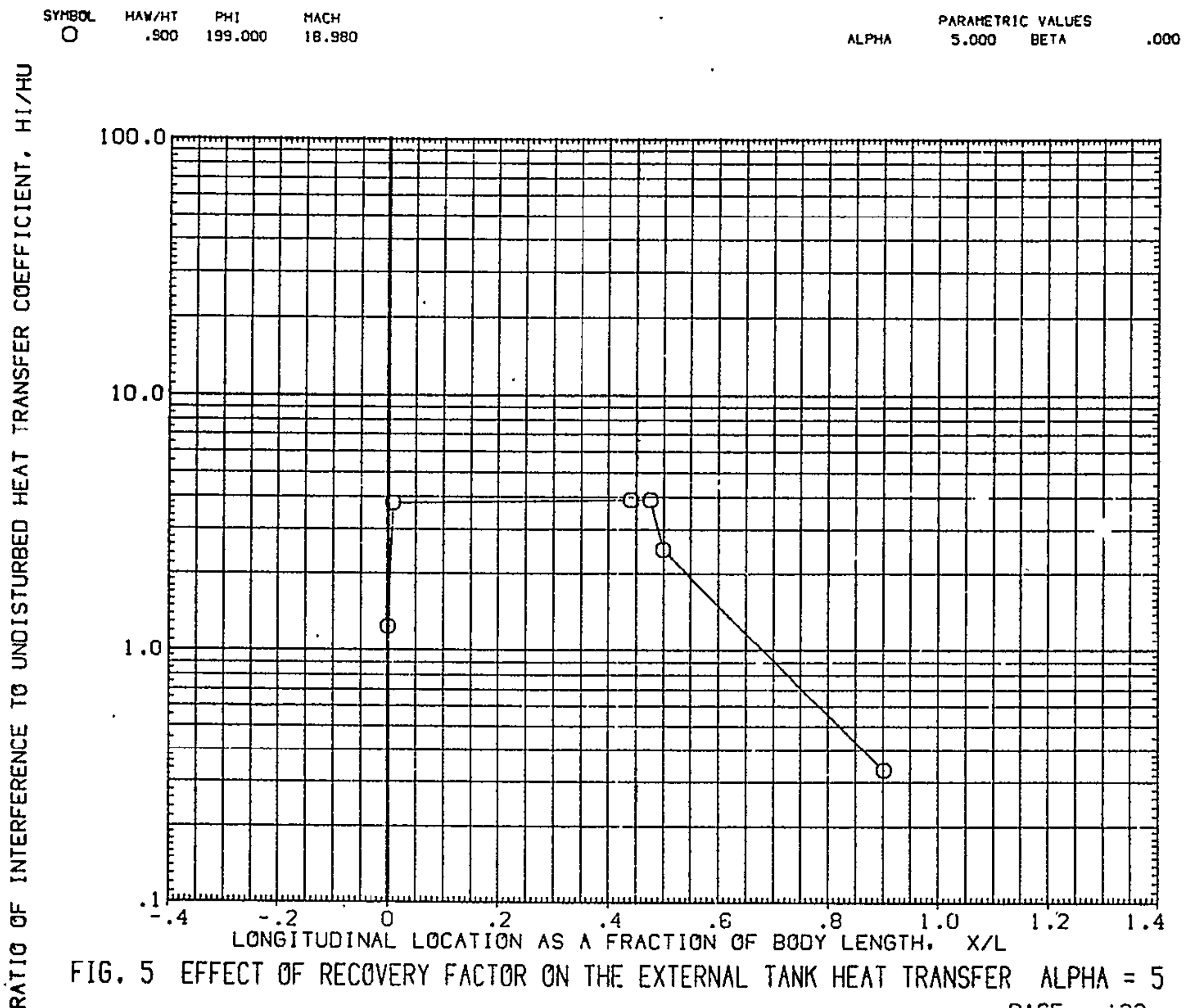

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

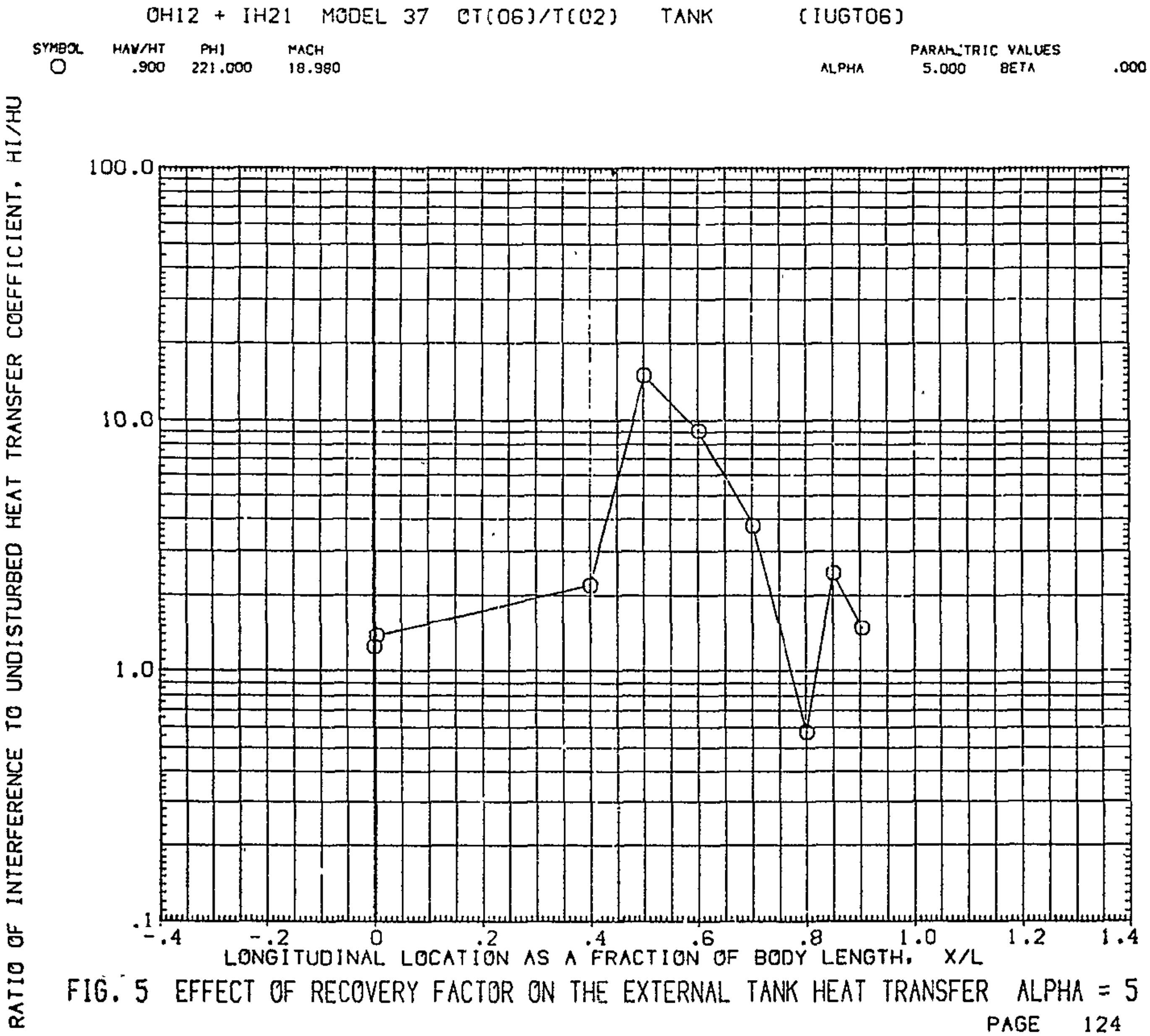

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

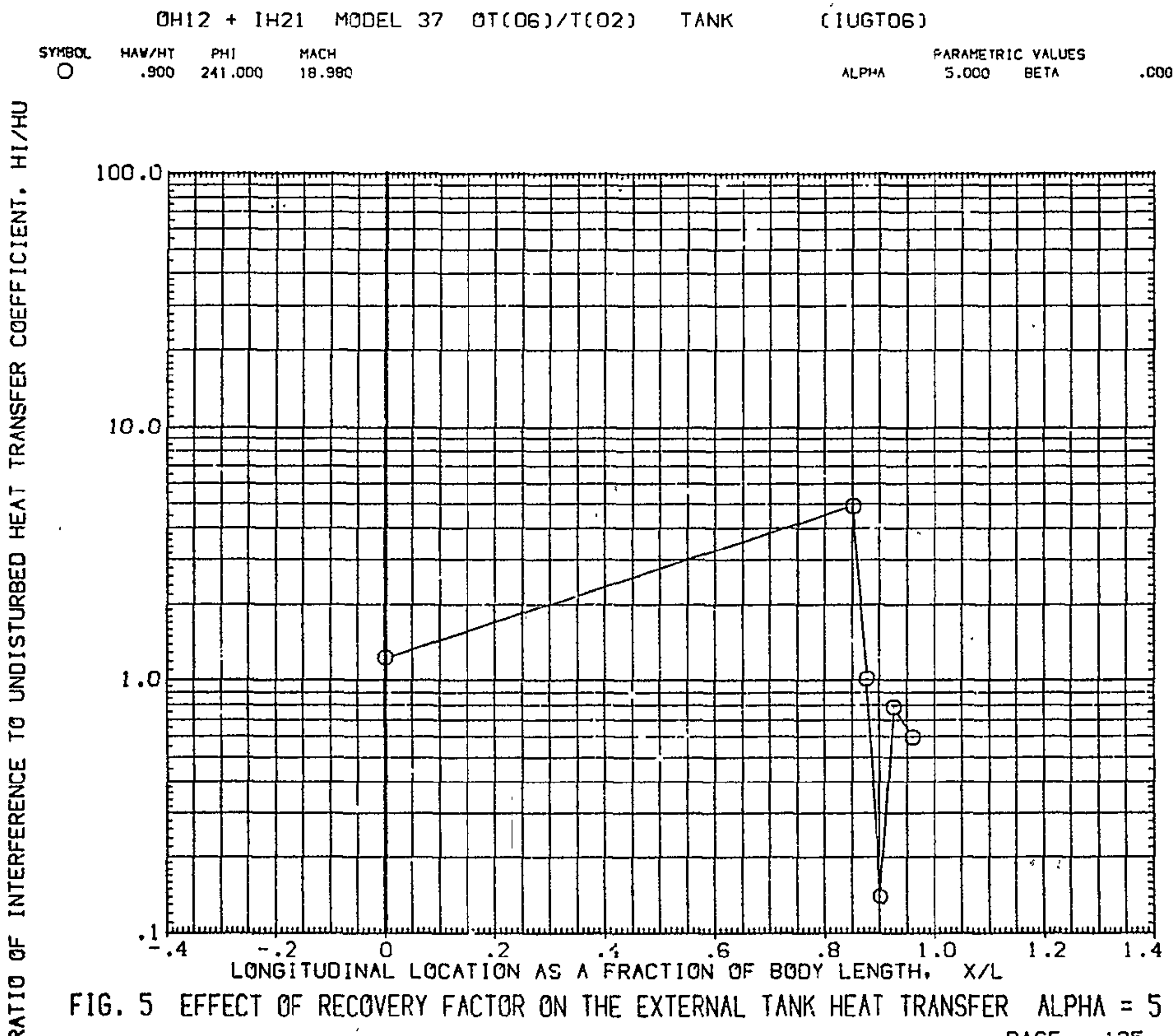

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

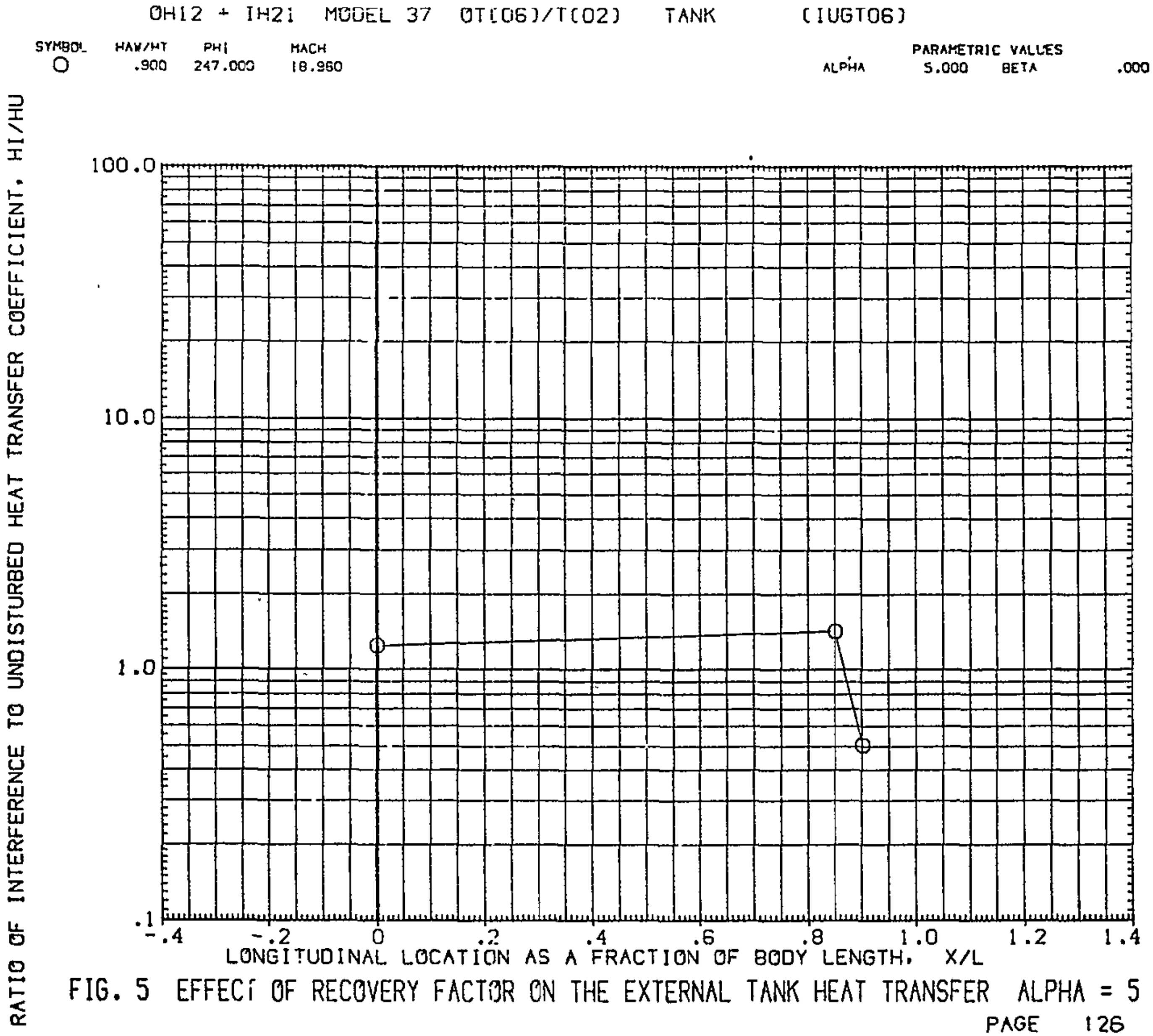

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/T(02) TANK (IUGT06)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	270.000	18.980	ALPHA	5.000	BETA	.000

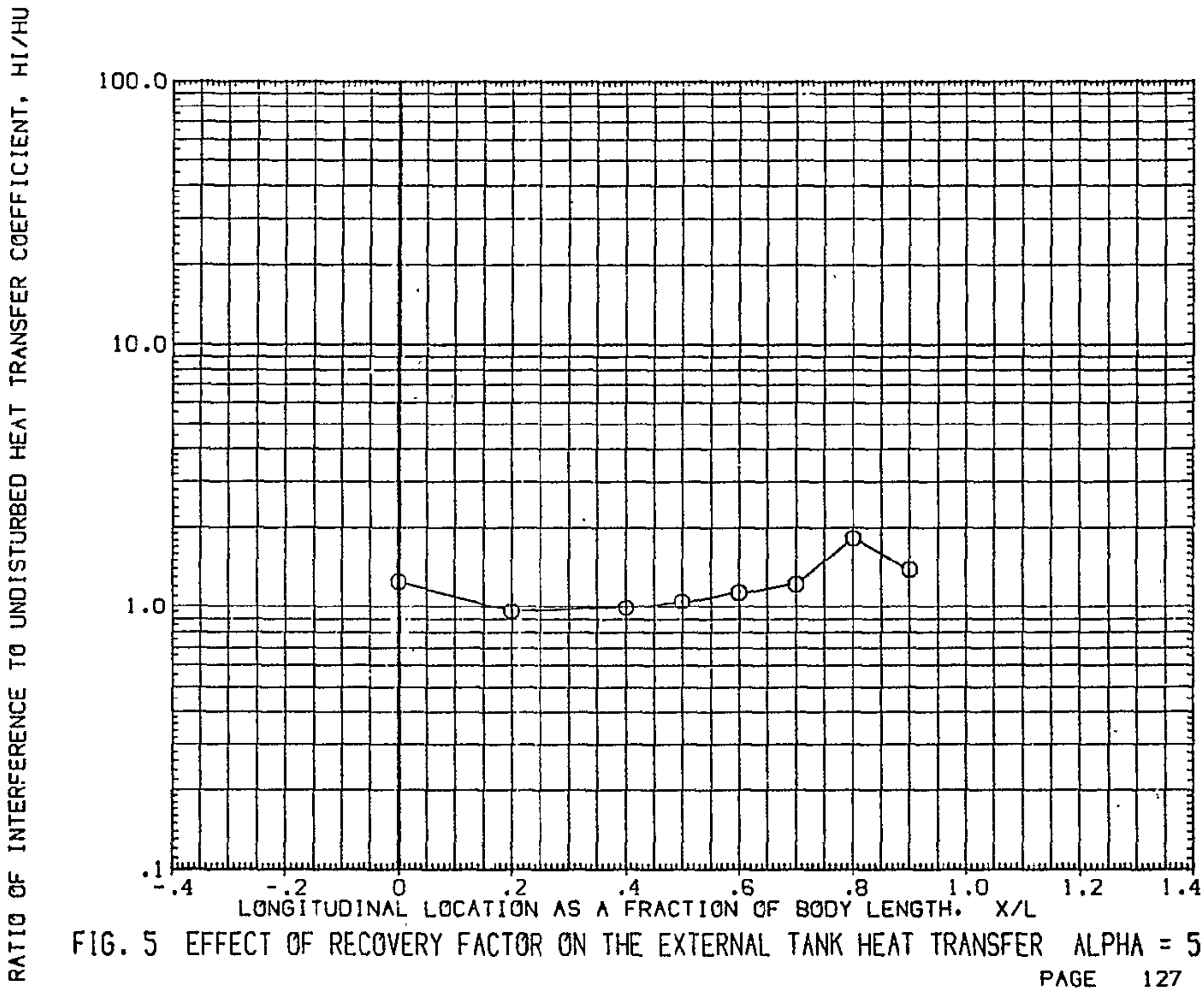

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/T(02) TANK (IUGT06)

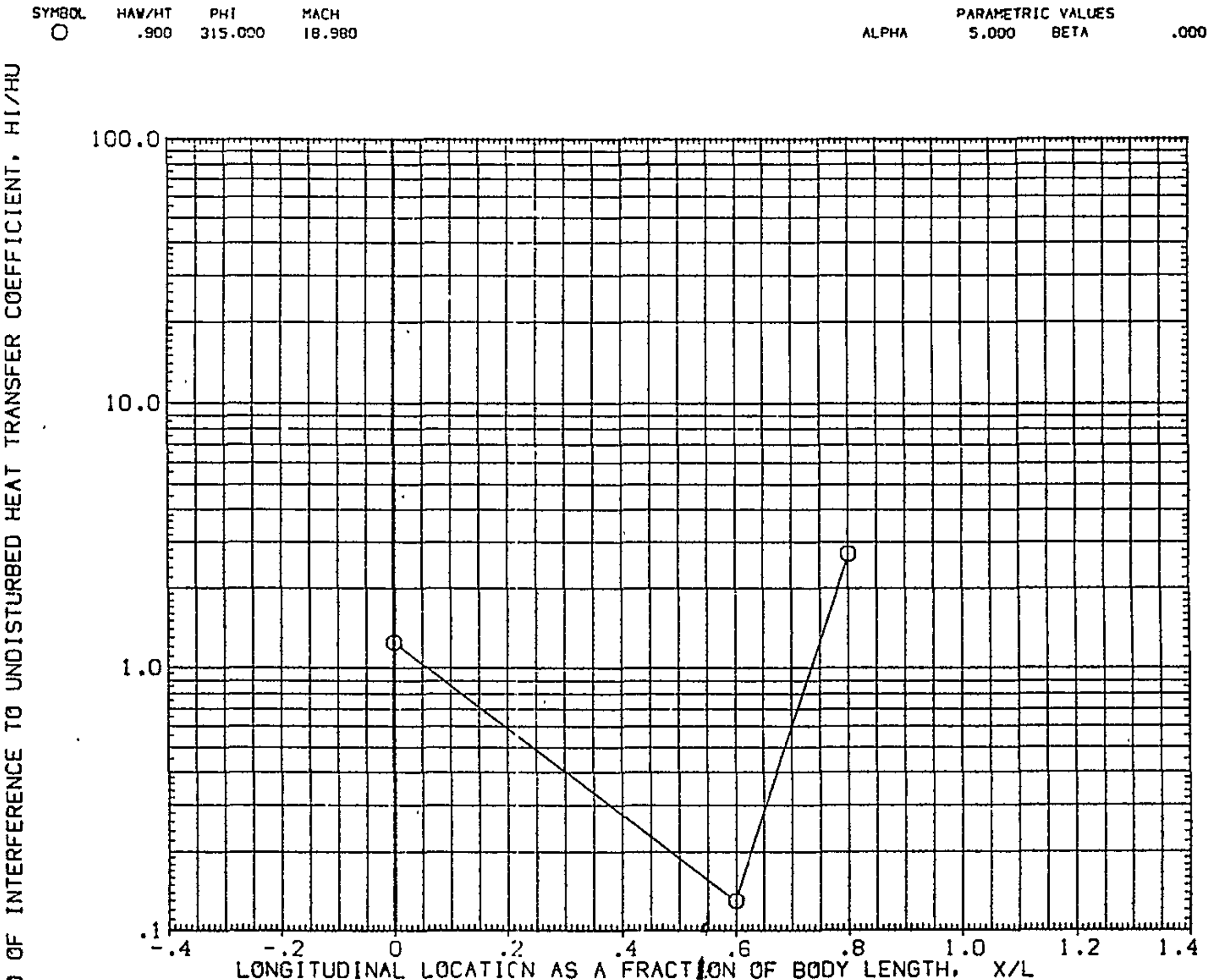

FIG. 5 EFFECT OF RECOVERY FACTOR ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 5

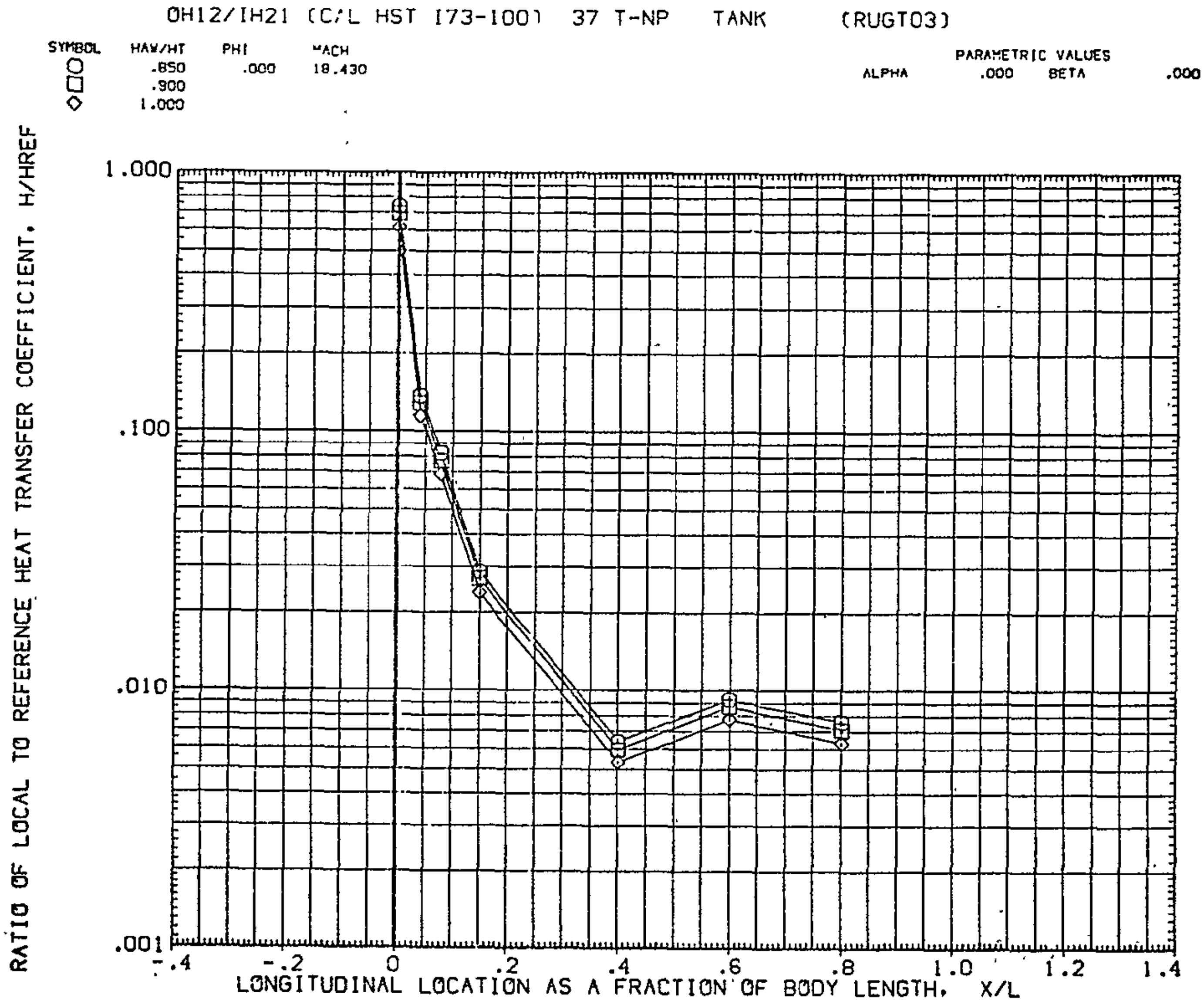

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 T-NP TANK (RUGT03)

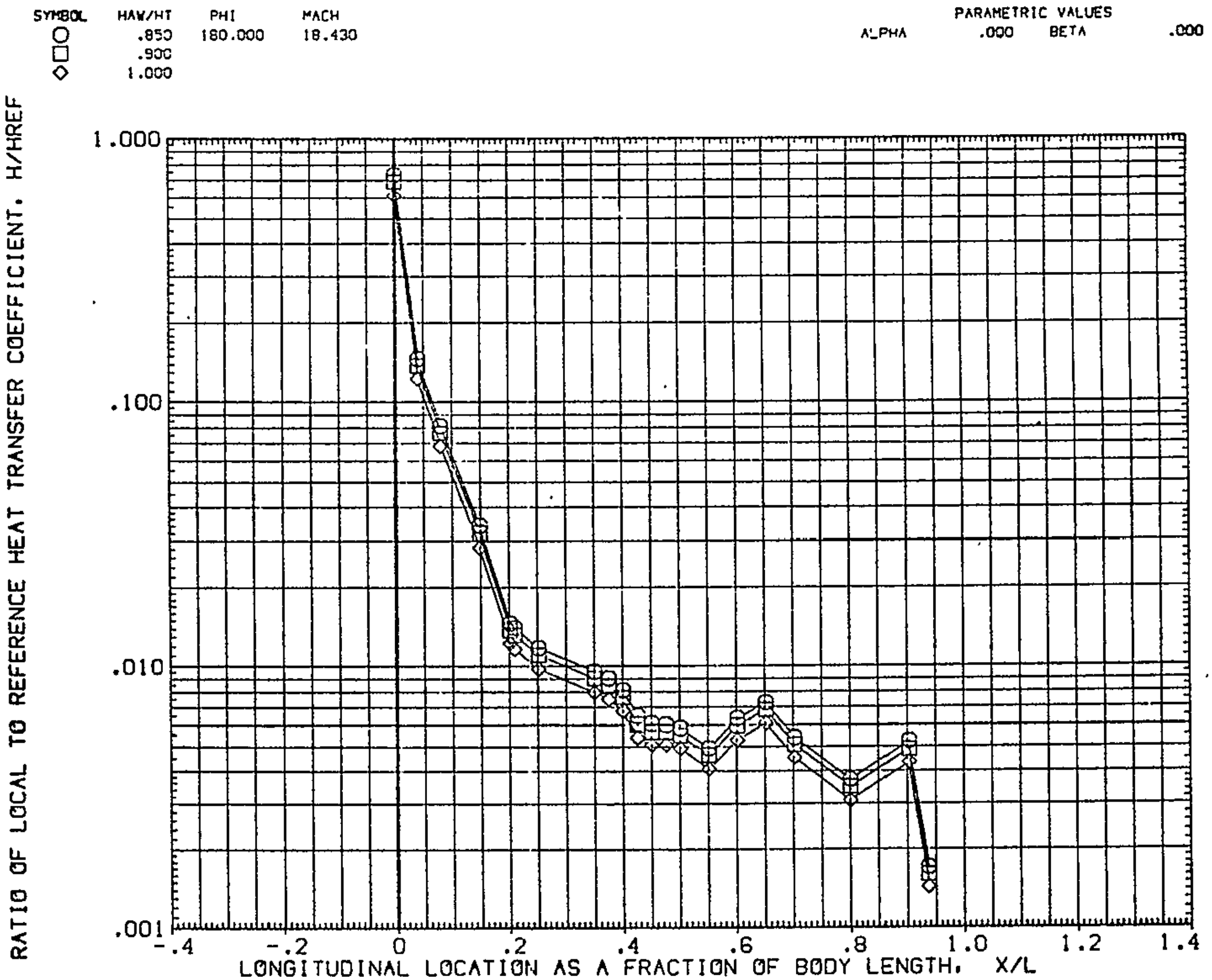

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

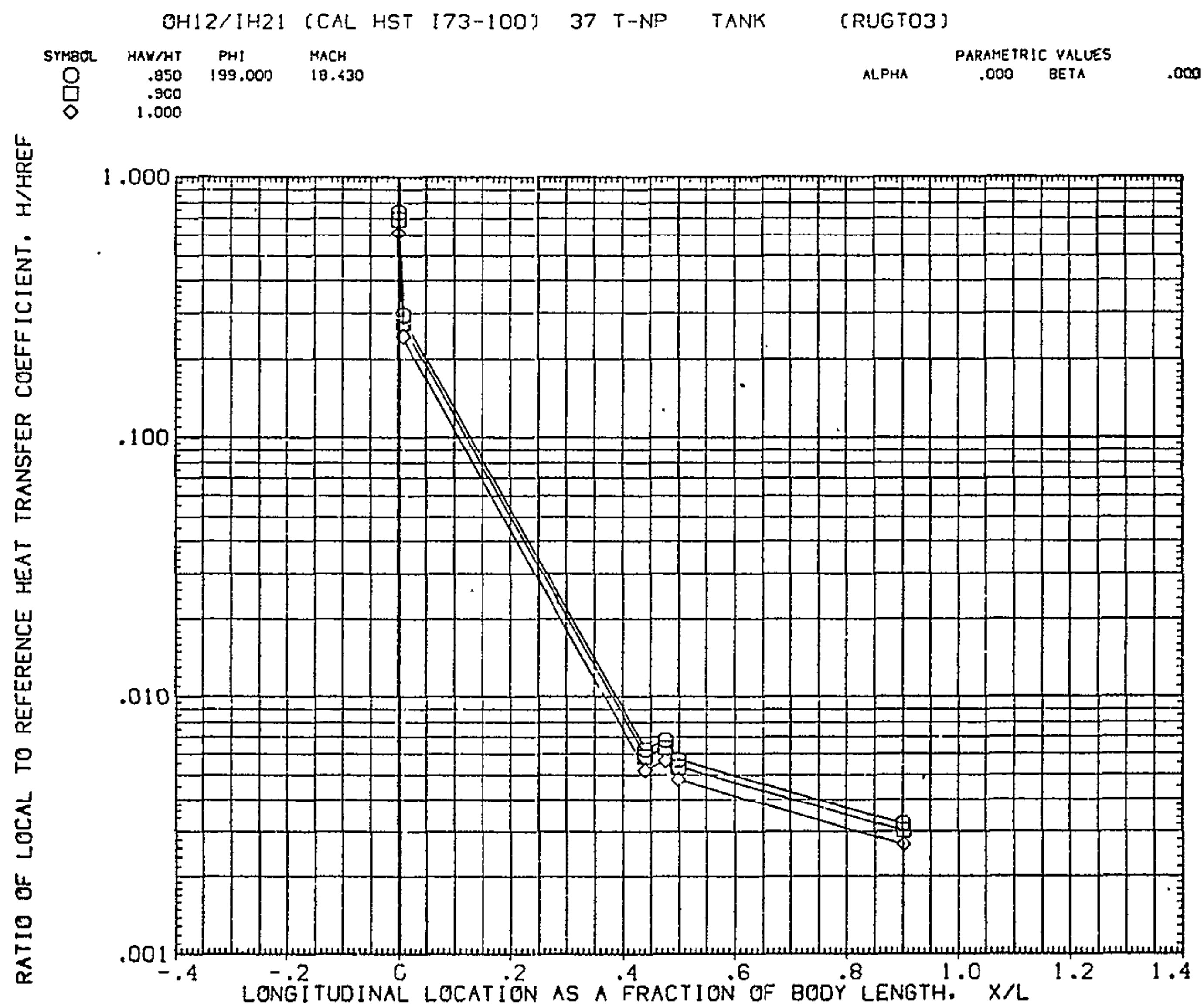

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 T-NP TANK (RUGT03)

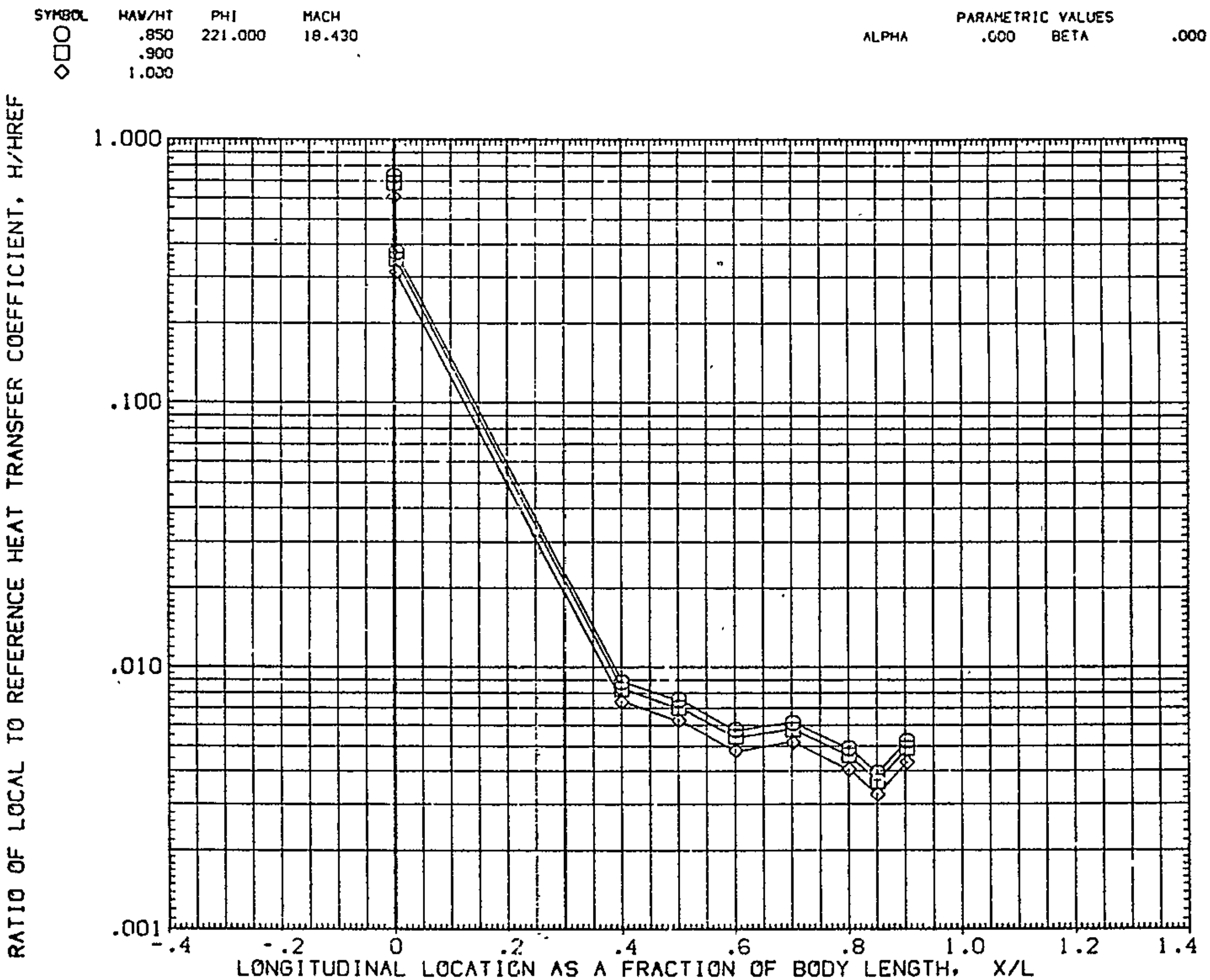

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

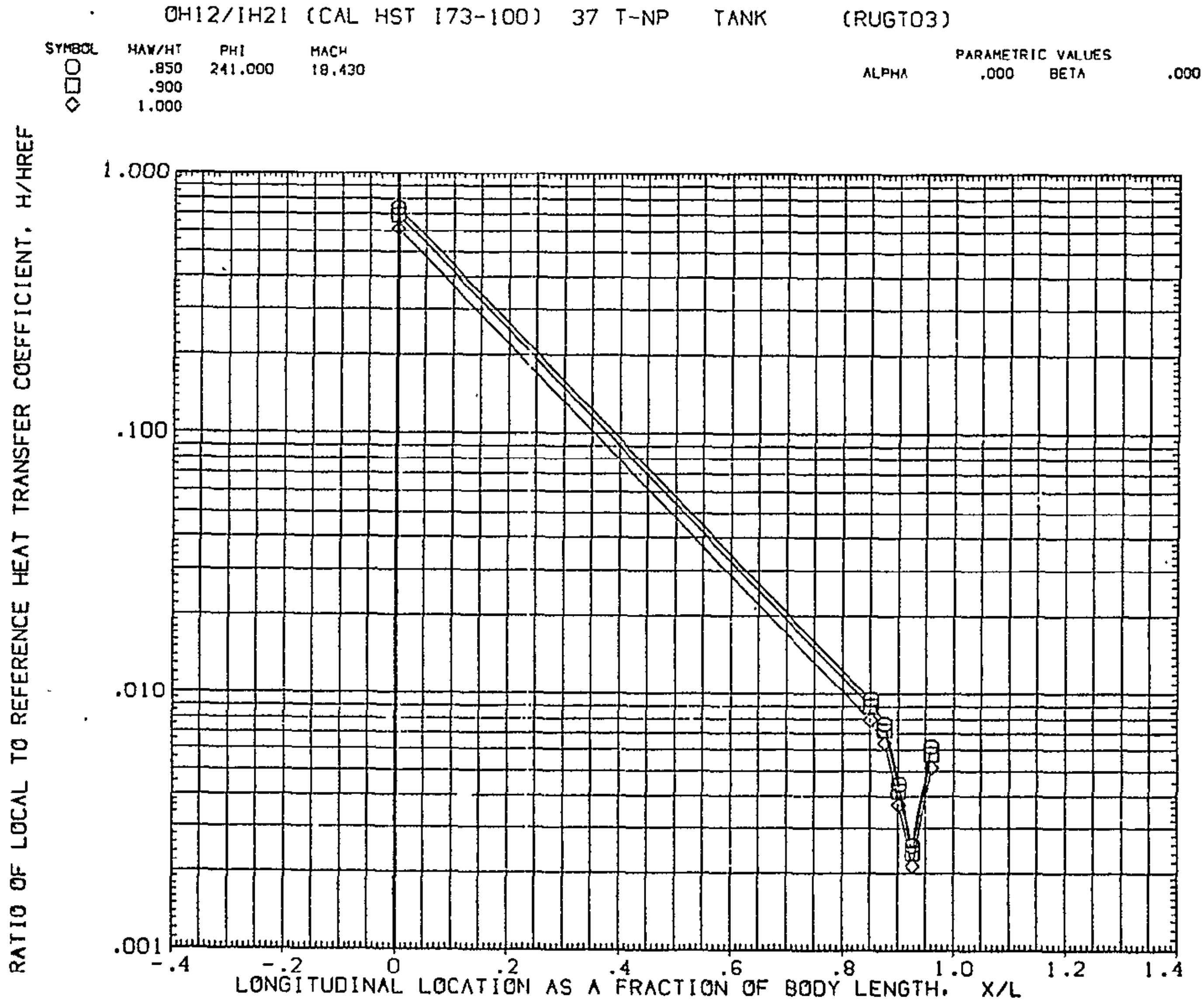

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

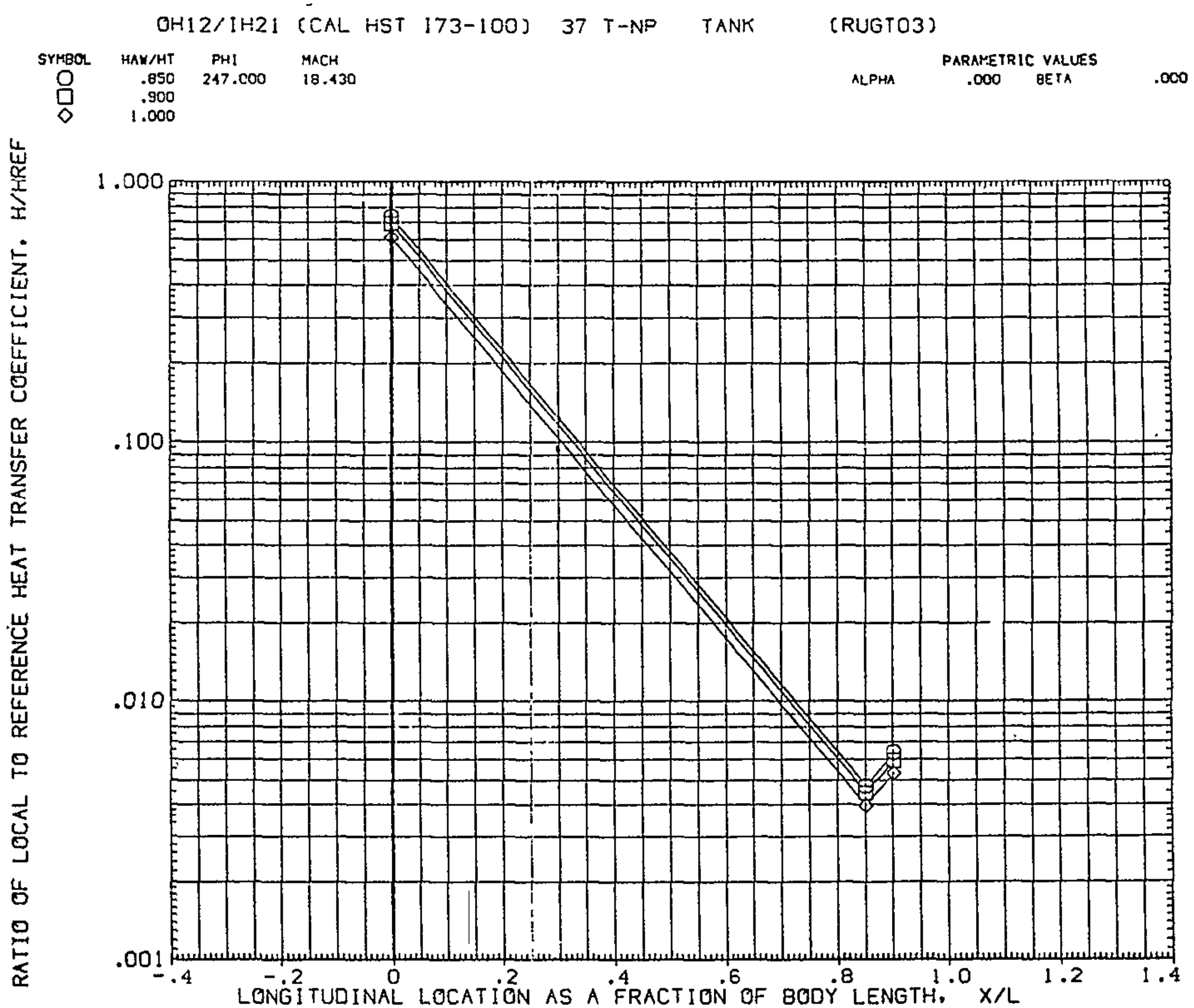

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

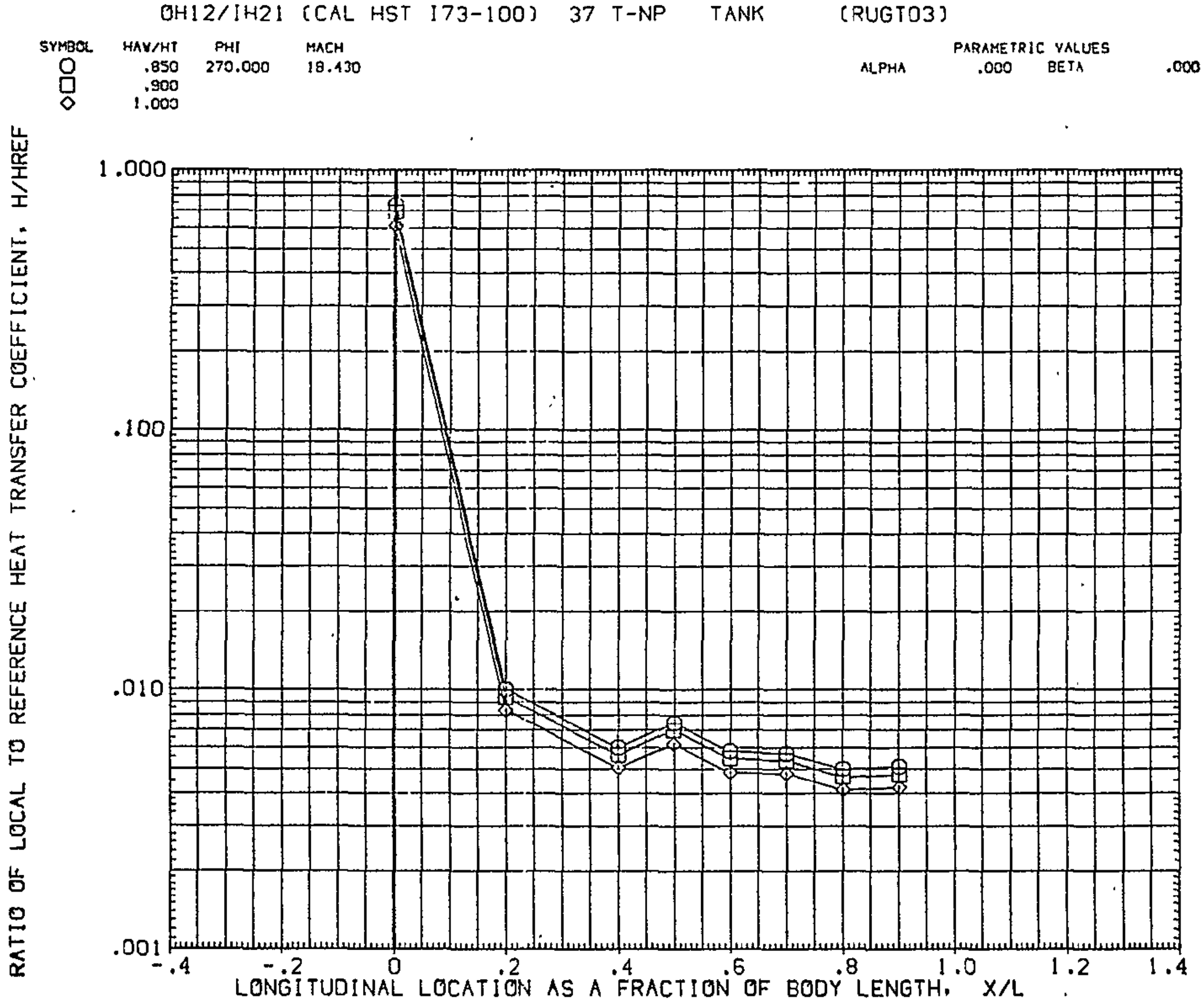

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

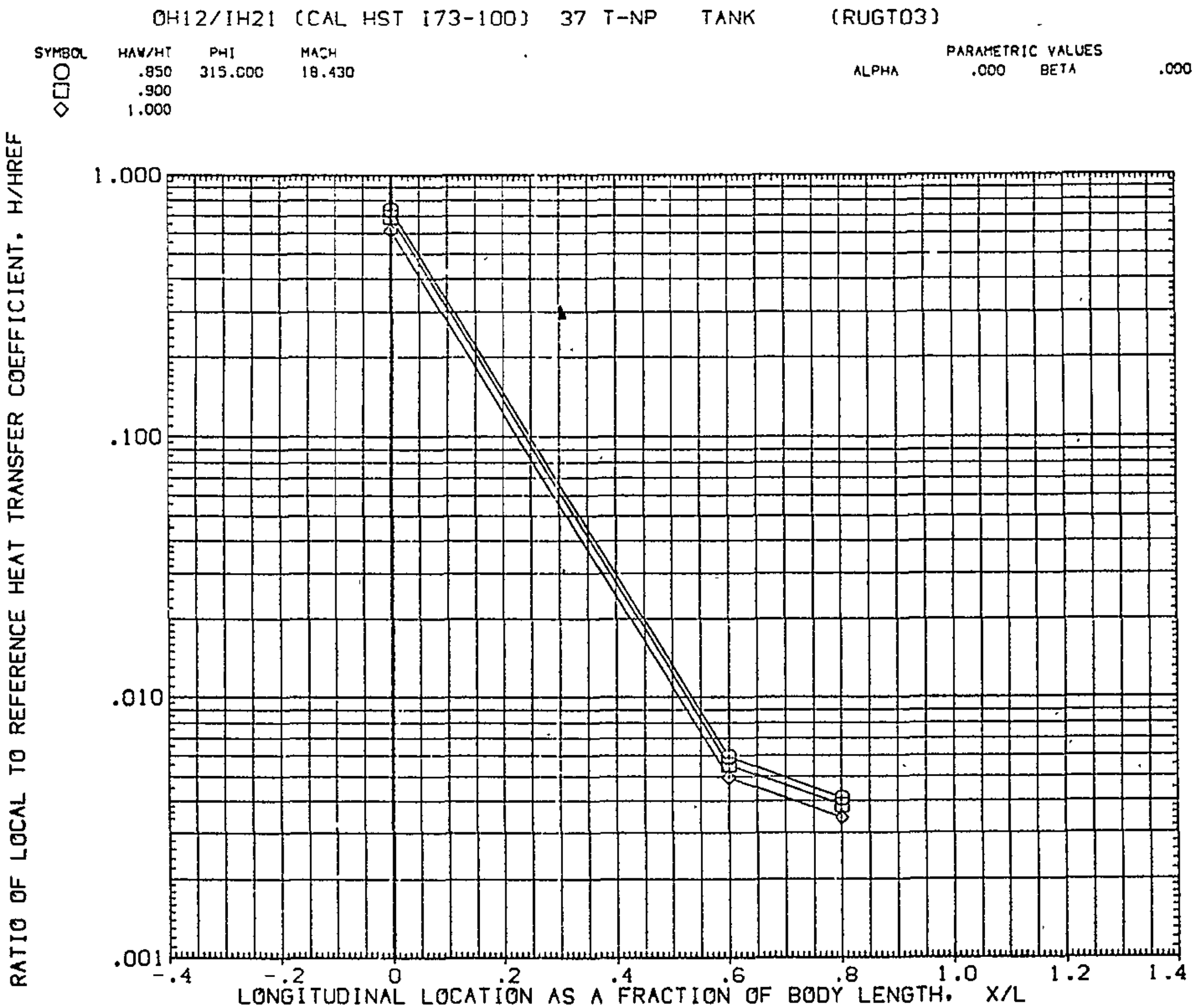

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 O T-NP TANK (RUGT04)

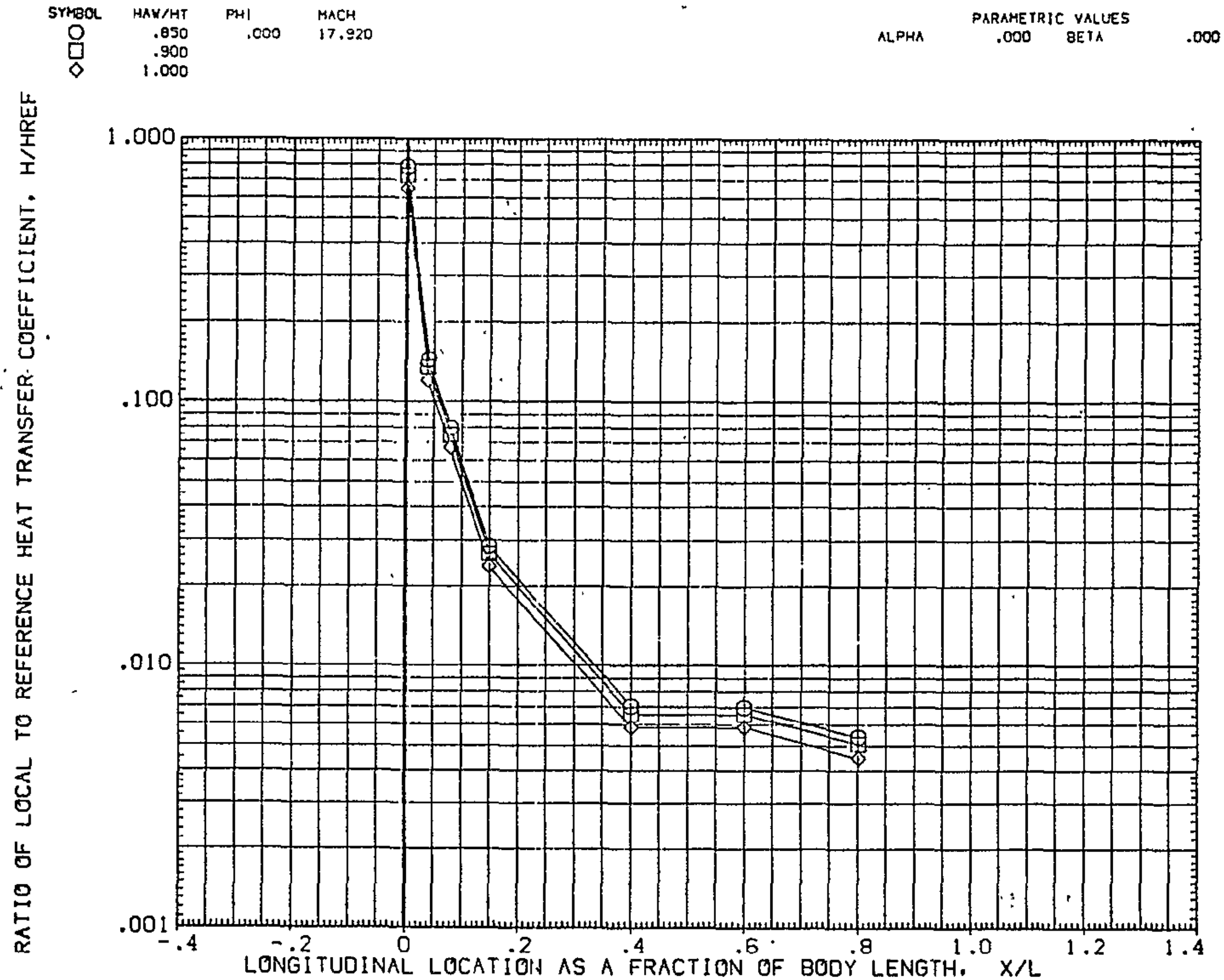

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 0 T-NP TANK   (RUGT04)

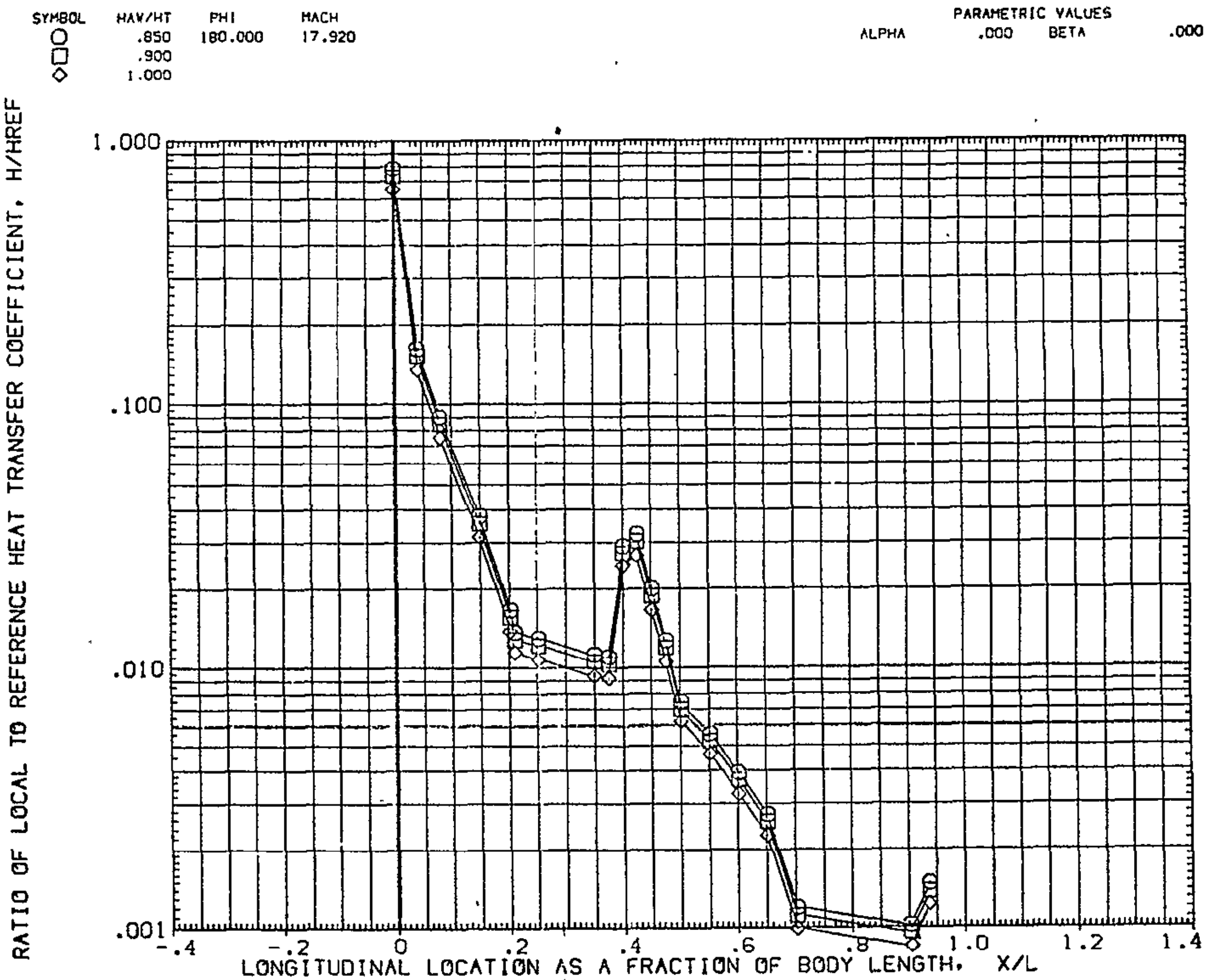

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

C-3

OH12/IH21 (CAL HST I73-100) 37 O T-NP TANK (RUGT04)

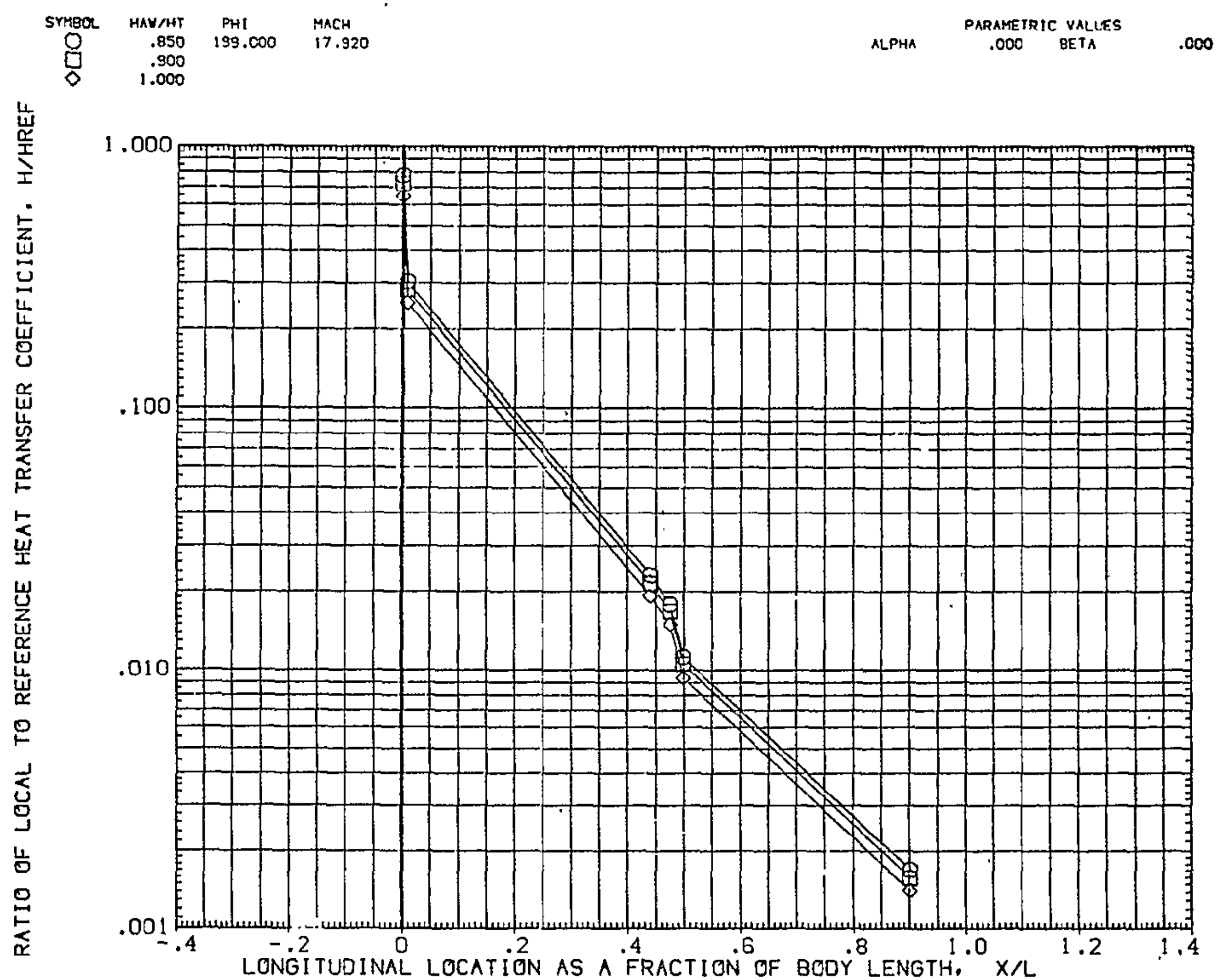

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

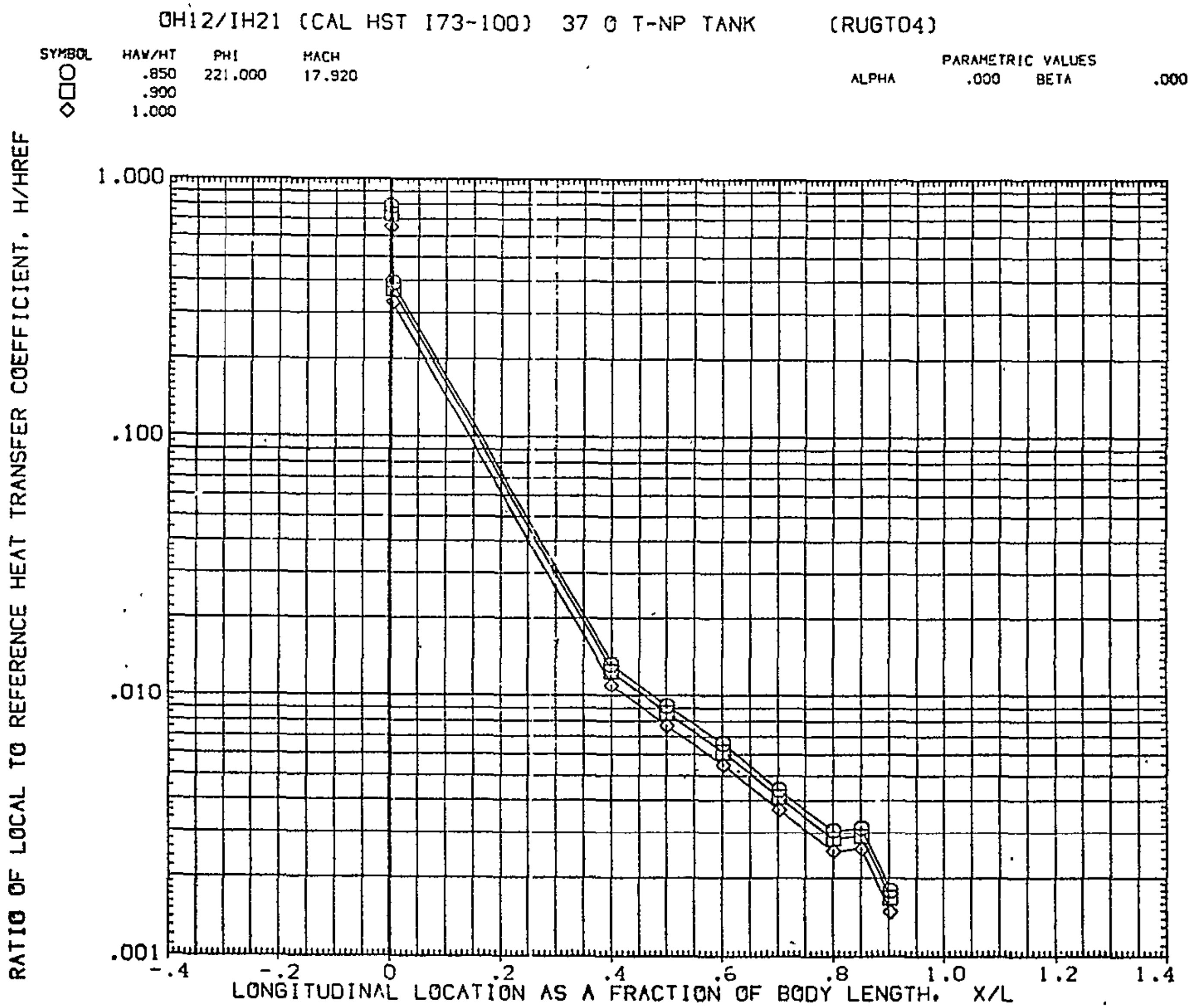

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

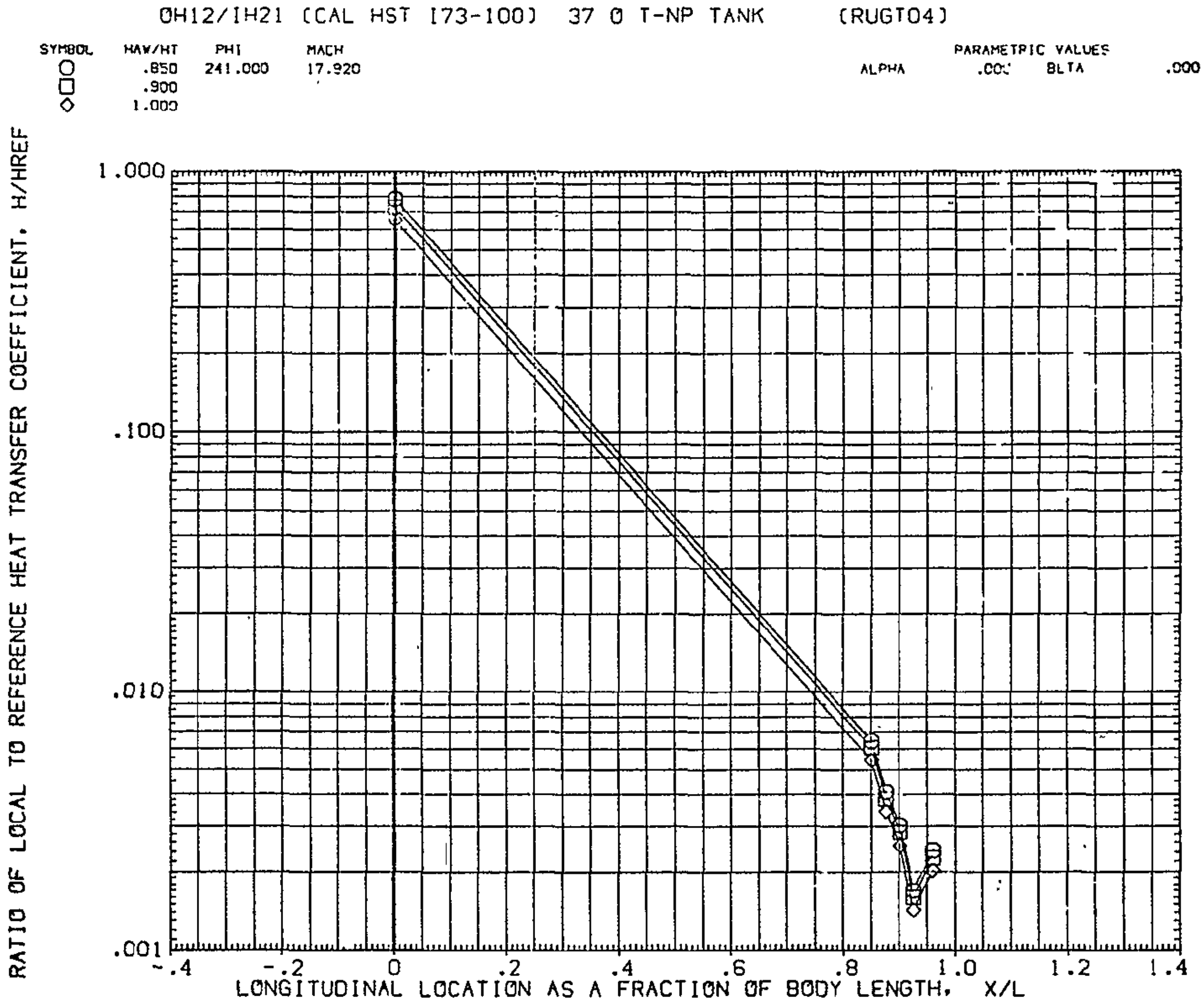

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 O T-NP TANK (RUGT04)

SYMBOL	HAW/HT	PHI	MACH
○	.850	247.000	17.920
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

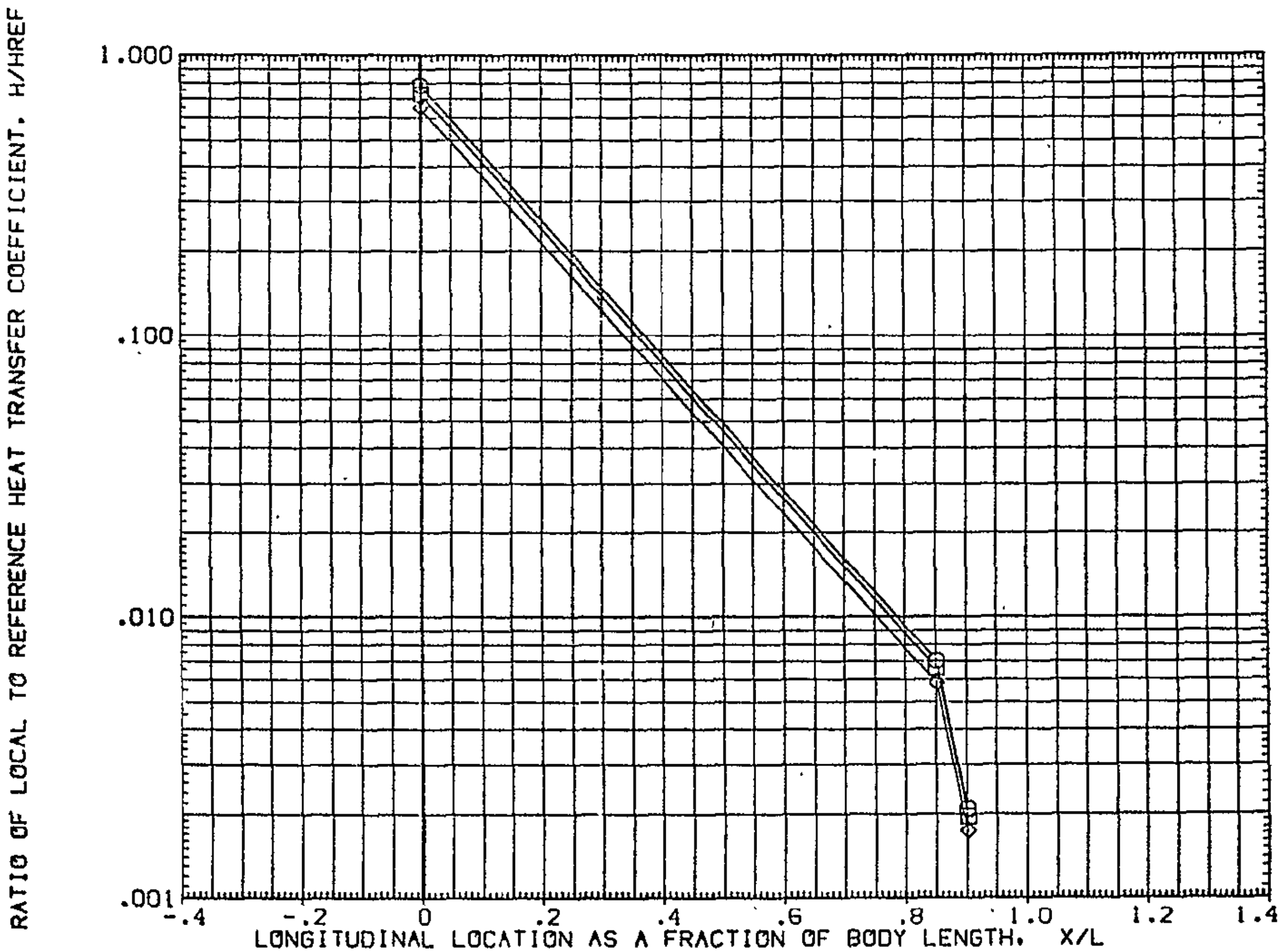

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

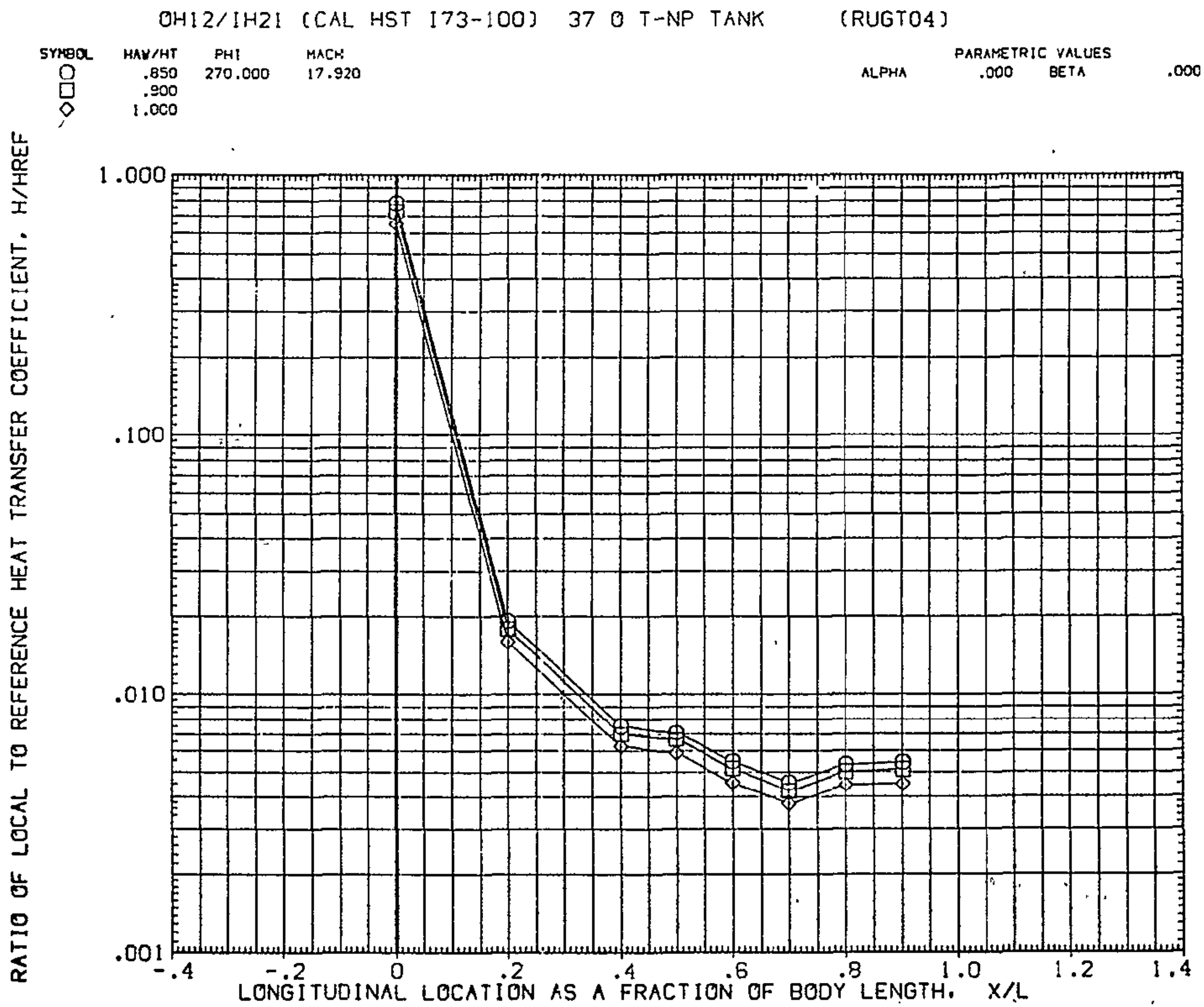

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12/IH21 (CAL HST I73-100) 37 O T-NP TANK (RUGT04)

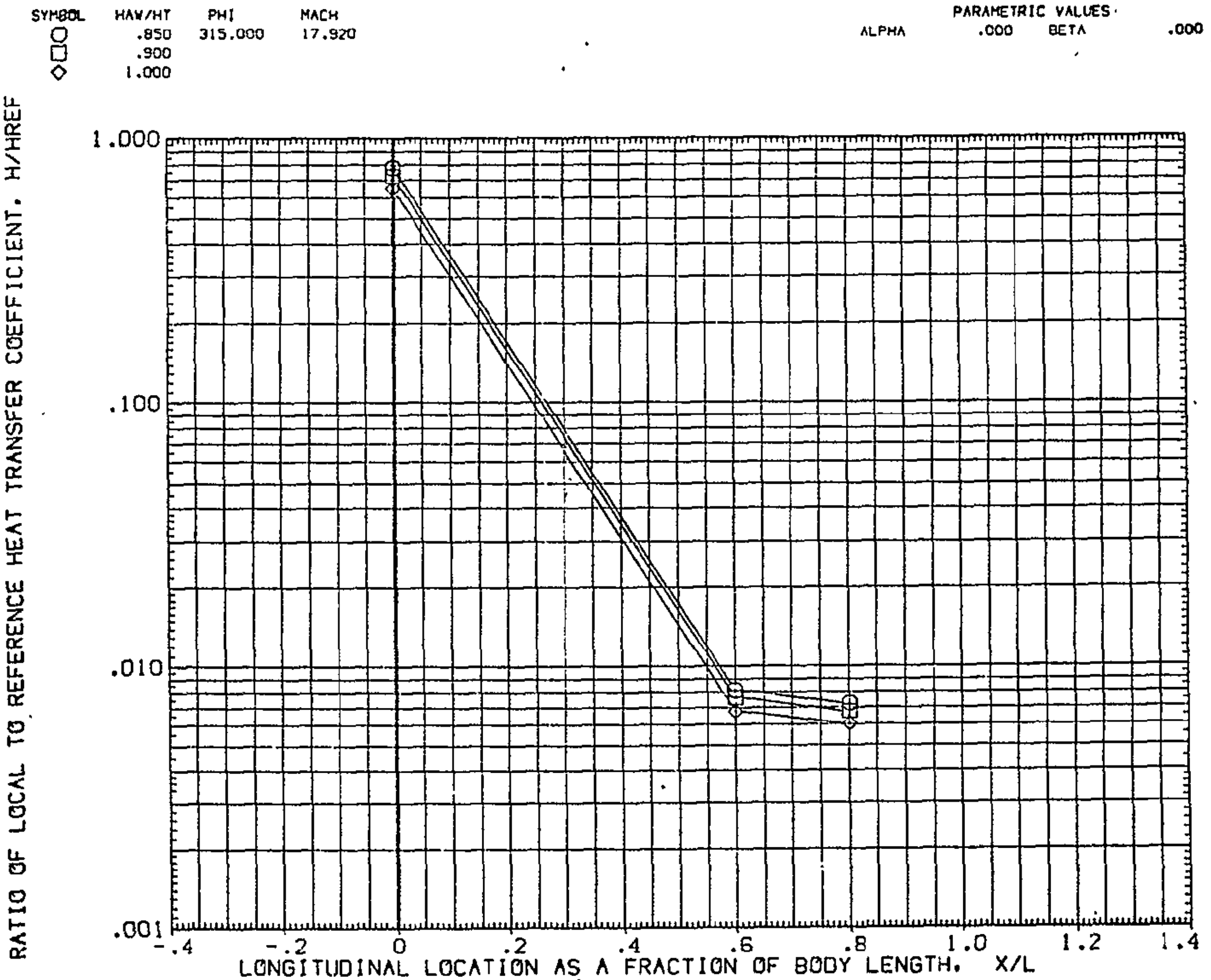

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12 + IH21 MODEL 37 OT-NP(4)/T-NP(3) TANK (IUGT04)

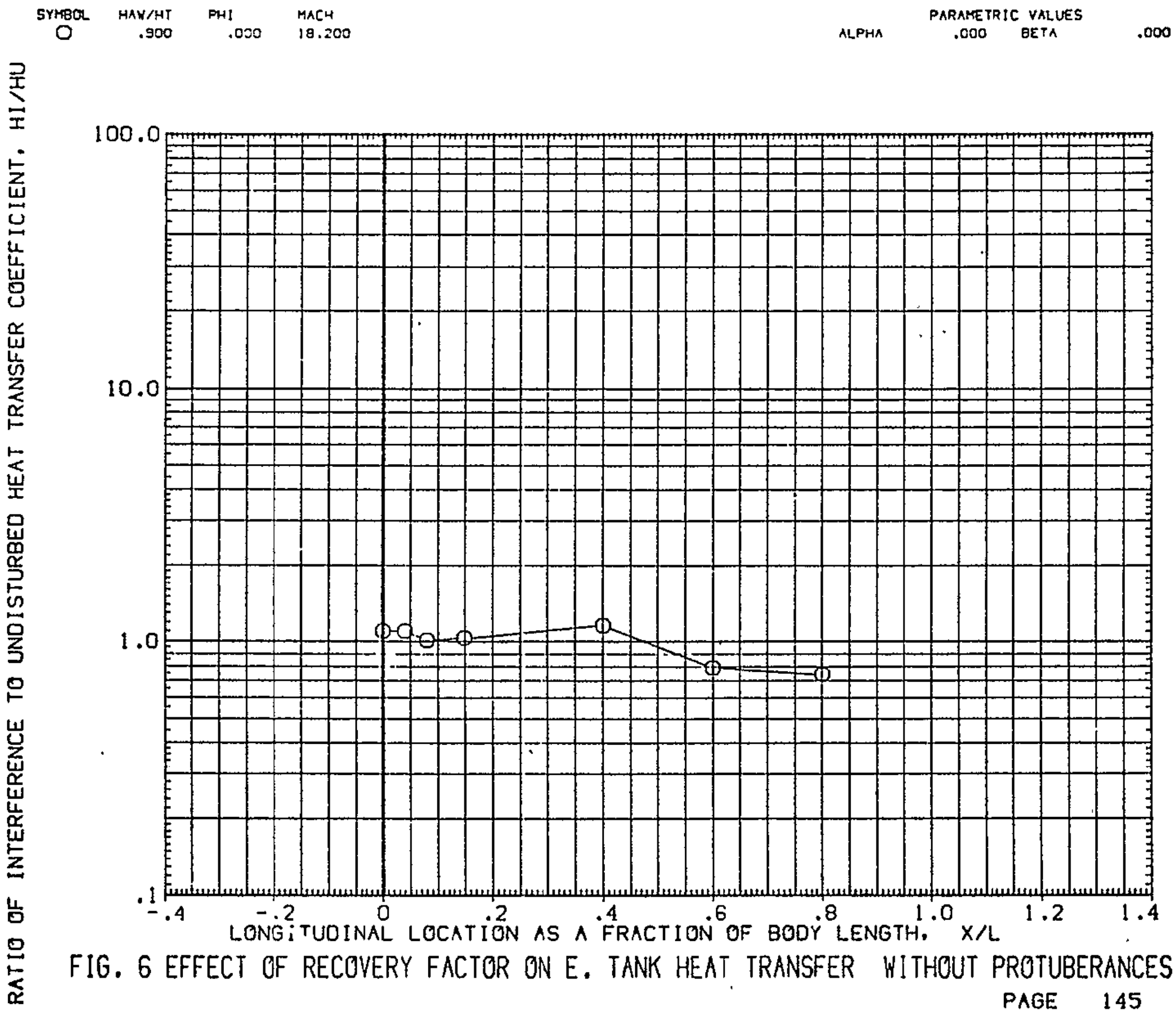

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

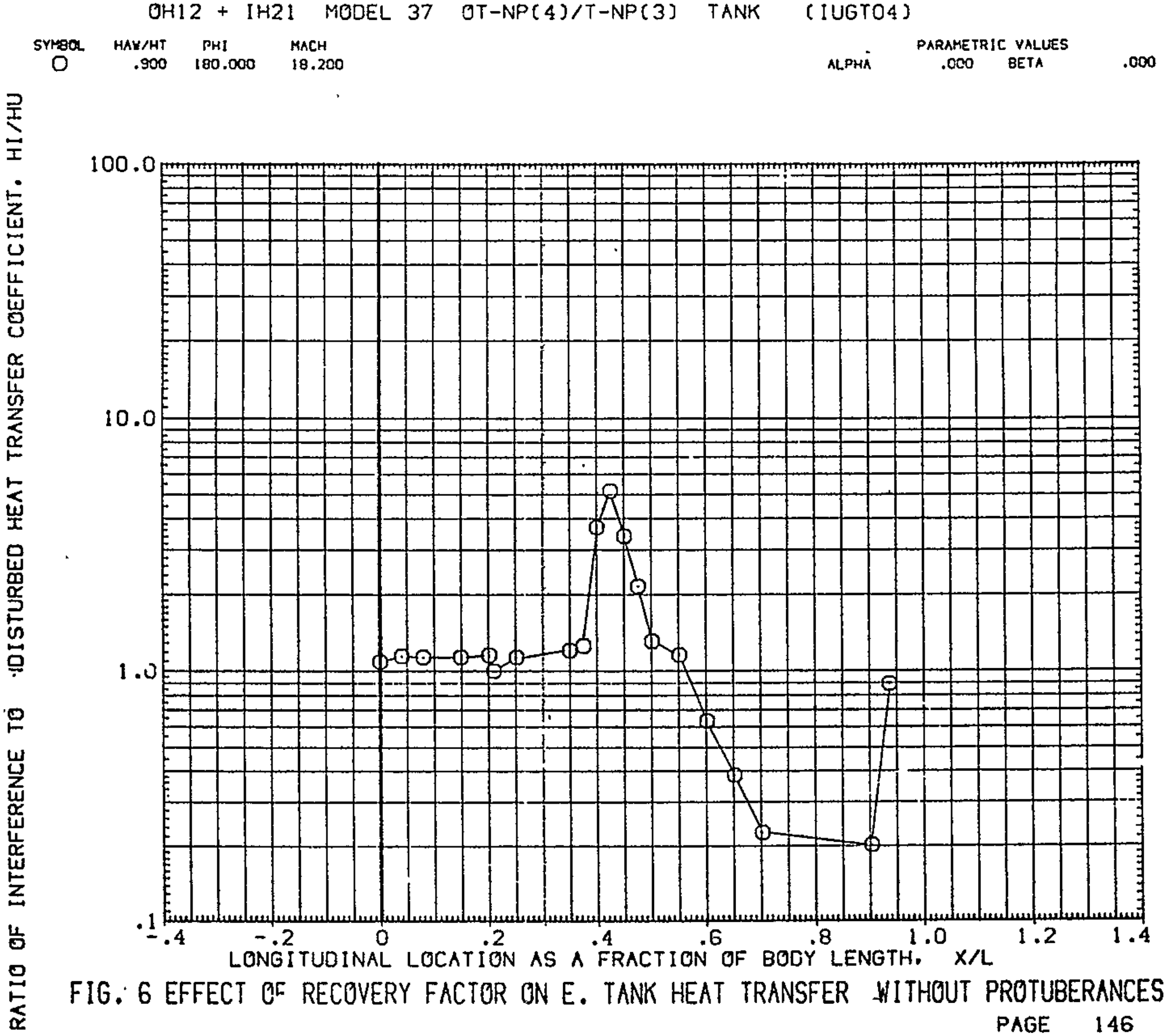

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

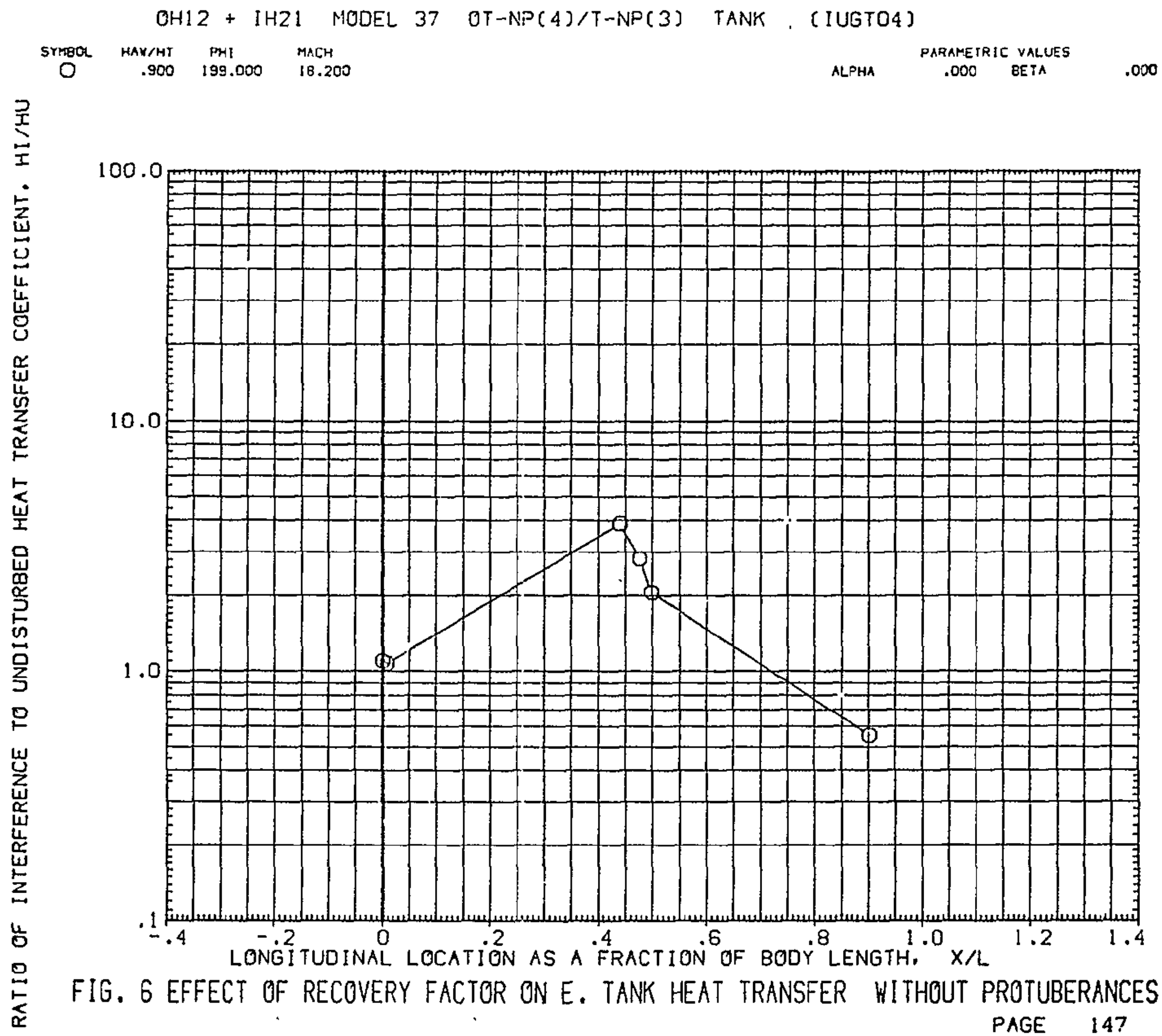

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12 + IH21 MODEL 37 OT-NP(4)/T-NP(3) TANK (IUGT04)

SYMBOL	HAW/HT	PHI	MACH
O	.900	221.000	18.200

PARAMETRIC VALUES
ALPHA .000 BETA .000

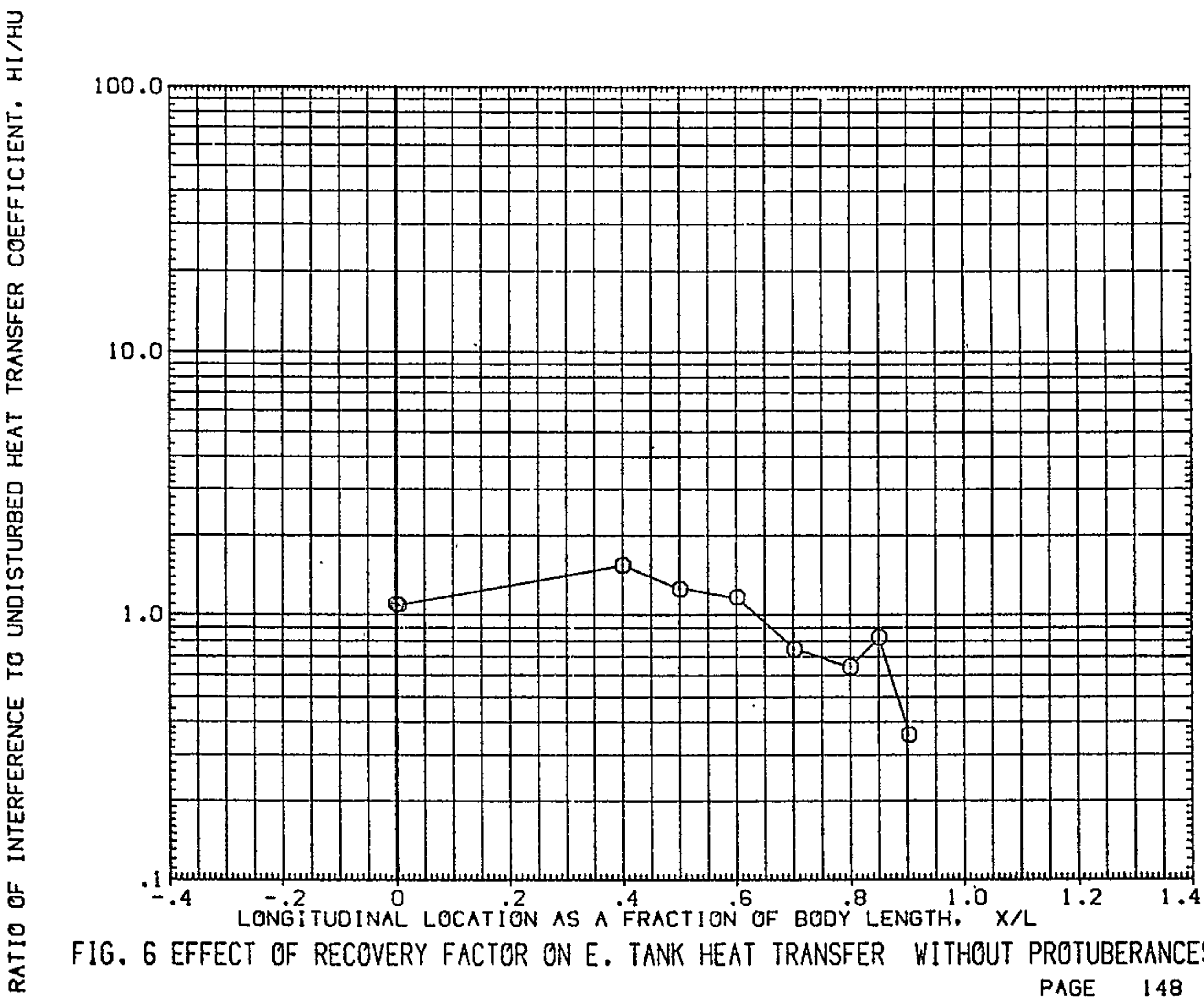

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

OH12 + IH21 MODEL 37 OT-NP(4)/T-NP(3) TANK (IUGT04)

SYMBOL	HAW/HT	PHI	MACH
O	.900	241.000	18.200

PARAMETRIC VALUES

ALPHA .000 BETA .000

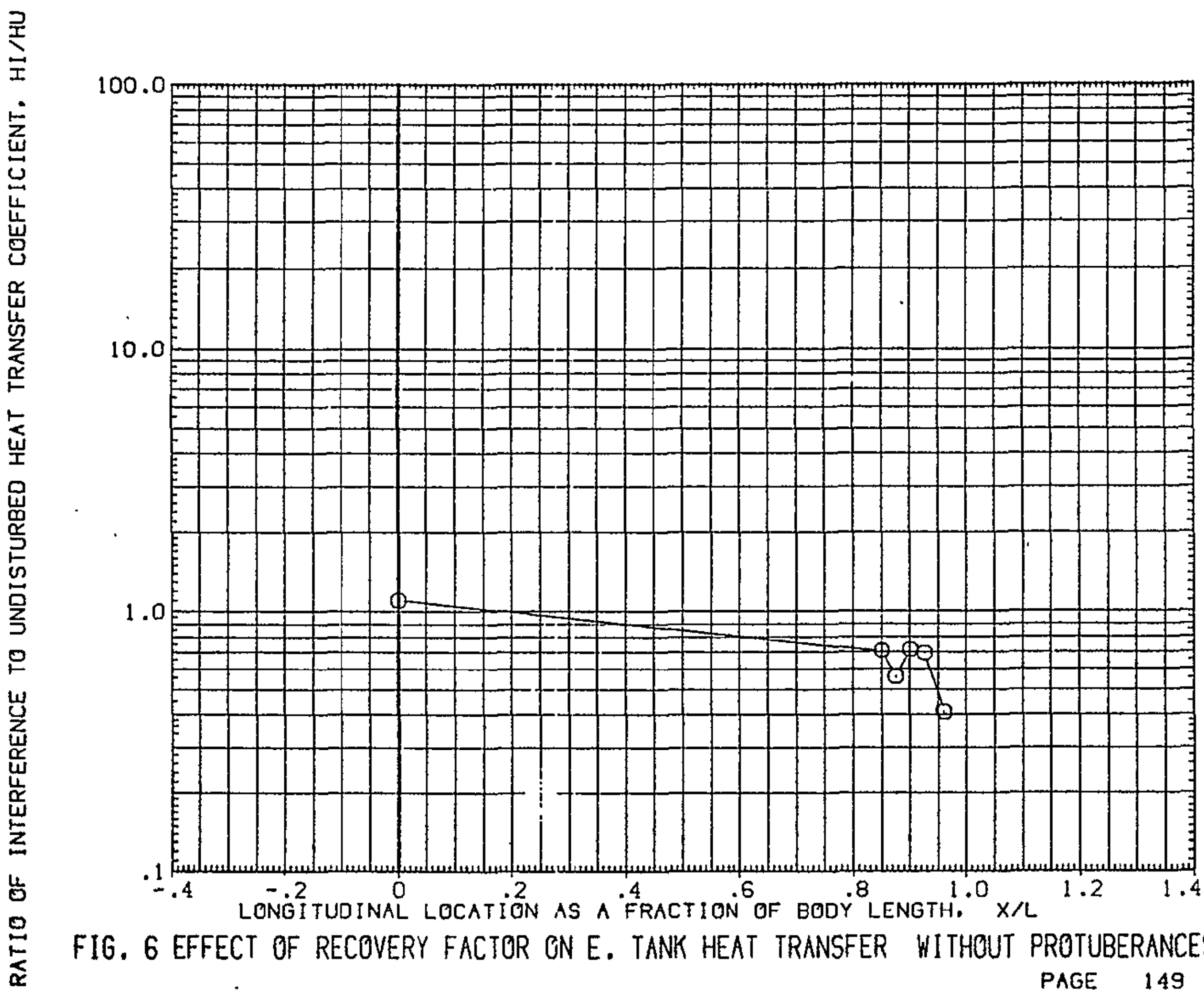

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

0H12 + IH21 MODEL 37 0T-NF(4)/T-NP(3) TANK (IUGT04)

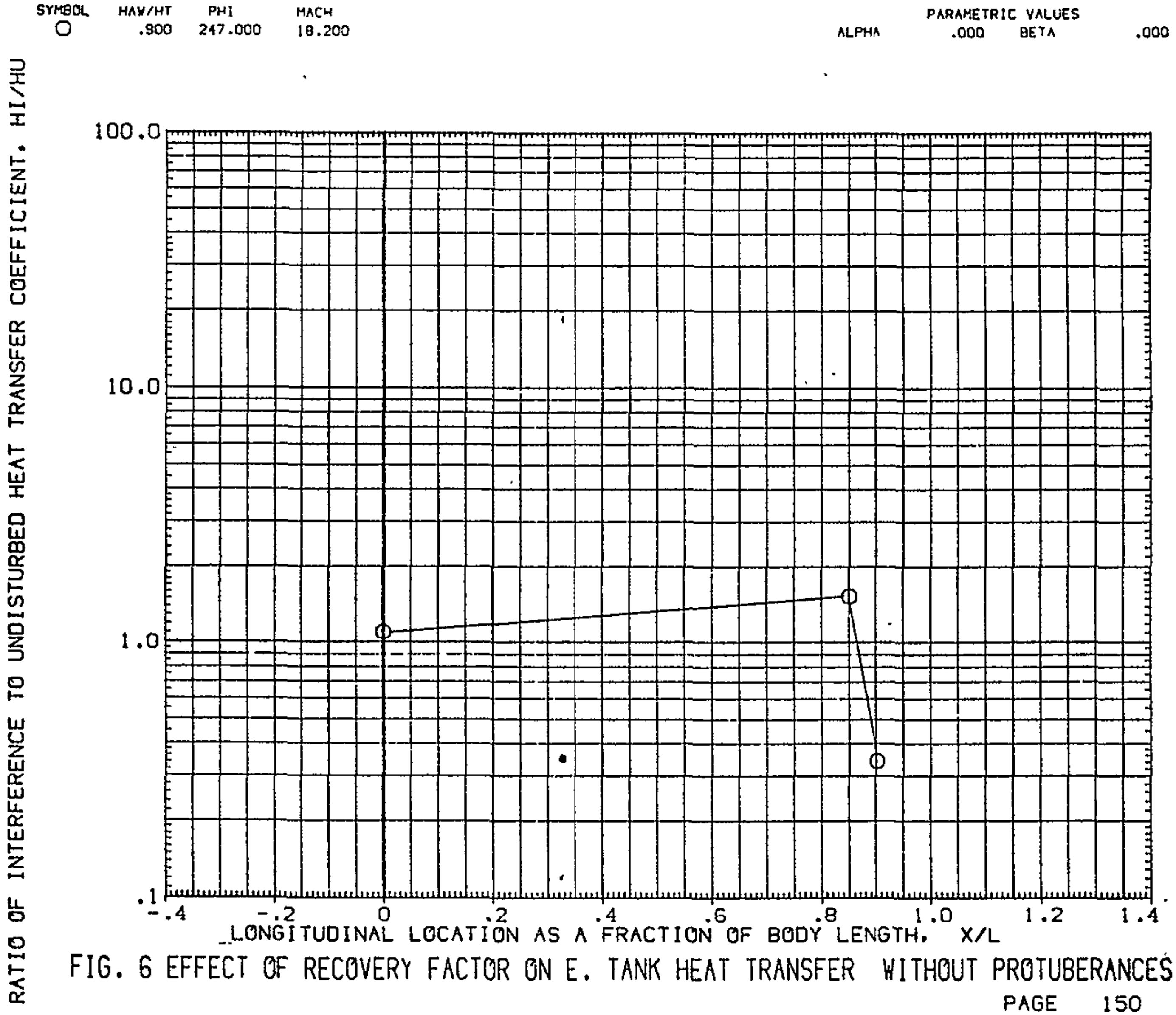

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

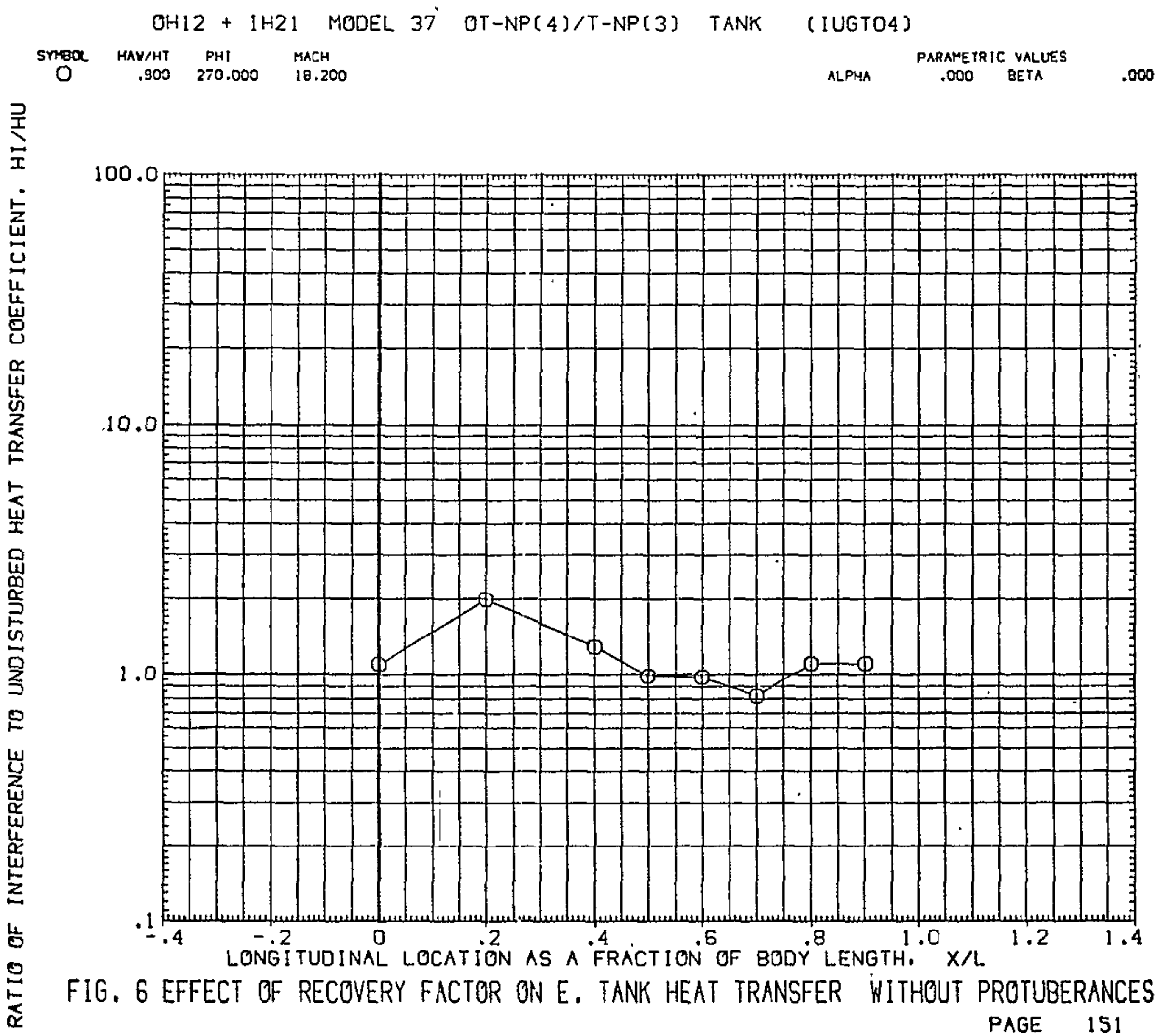

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

0H12 + IH21 MODEL 37 0T-NP(4)/T-NP(3) TANK (IUGT04)

SYMBOL	HAW/HT	PHI	MACH
O	.900	315.000	18.200

PARAMETRIC VALUES

ALPHA .000 BETA .000

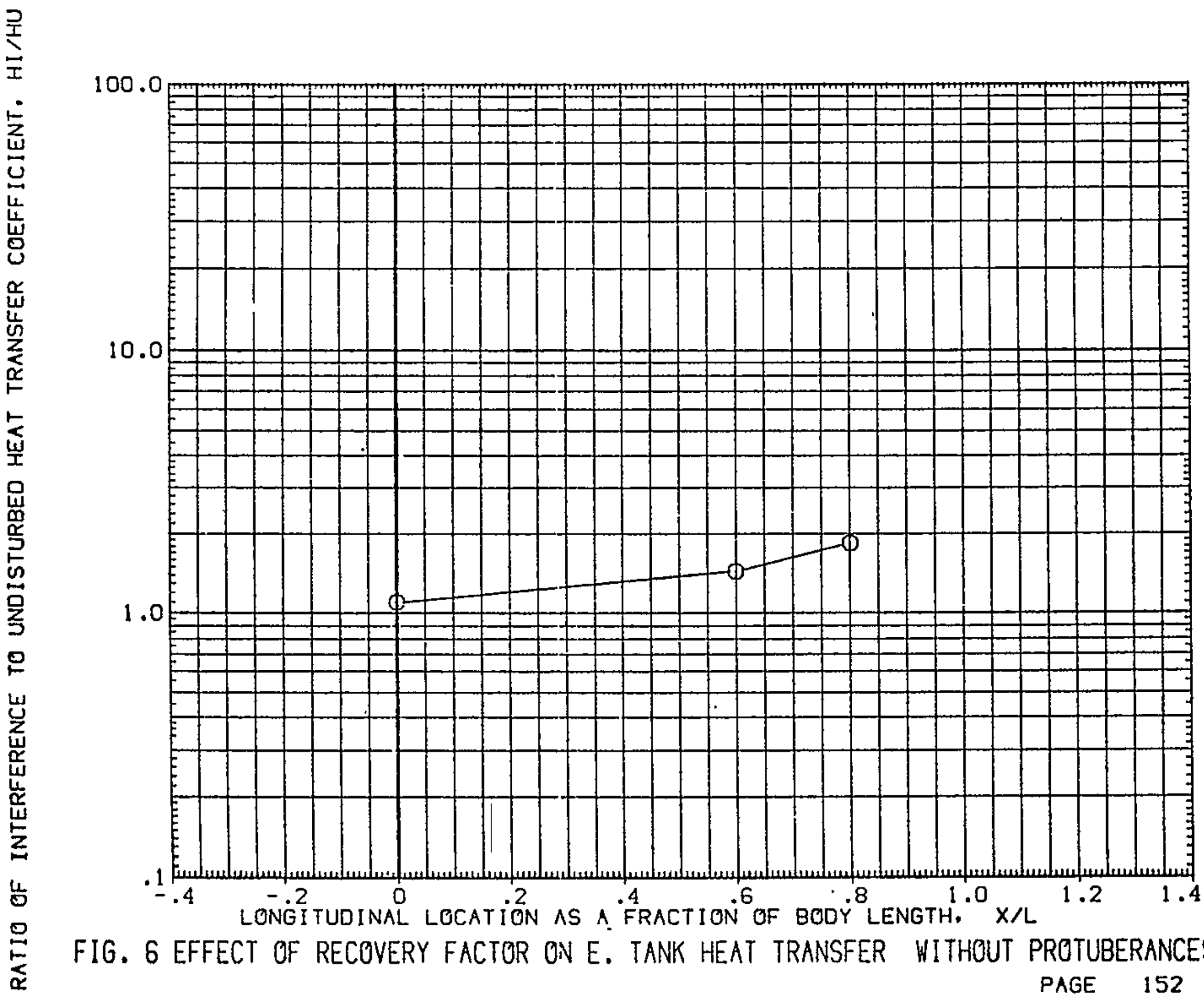

FIG. 6 EFFECT OF RECOVERY FACTOR ON E. TANK HEAT TRANSFER WITHOUT PROTUBERANCES

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

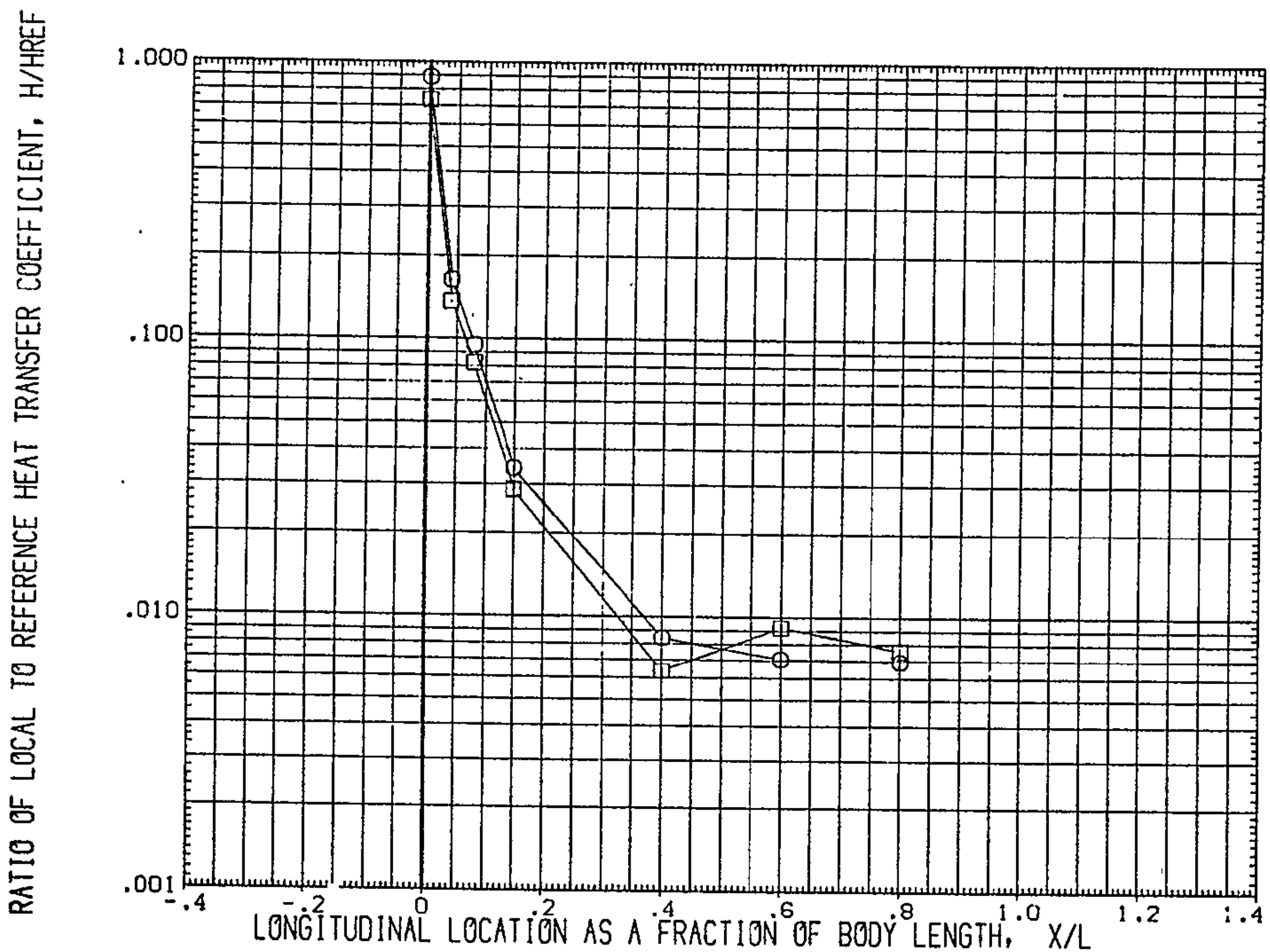

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = .000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

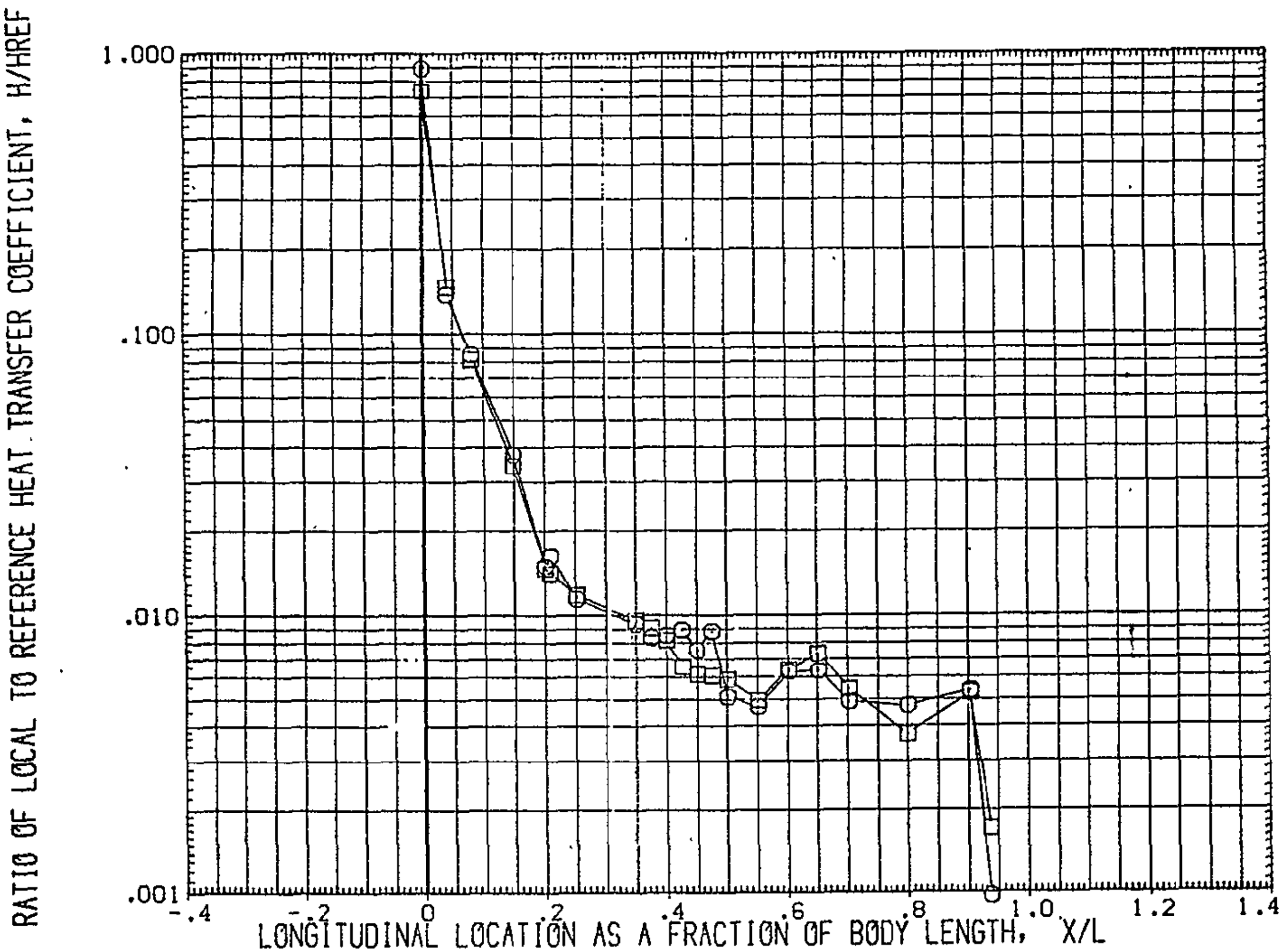

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 180.000

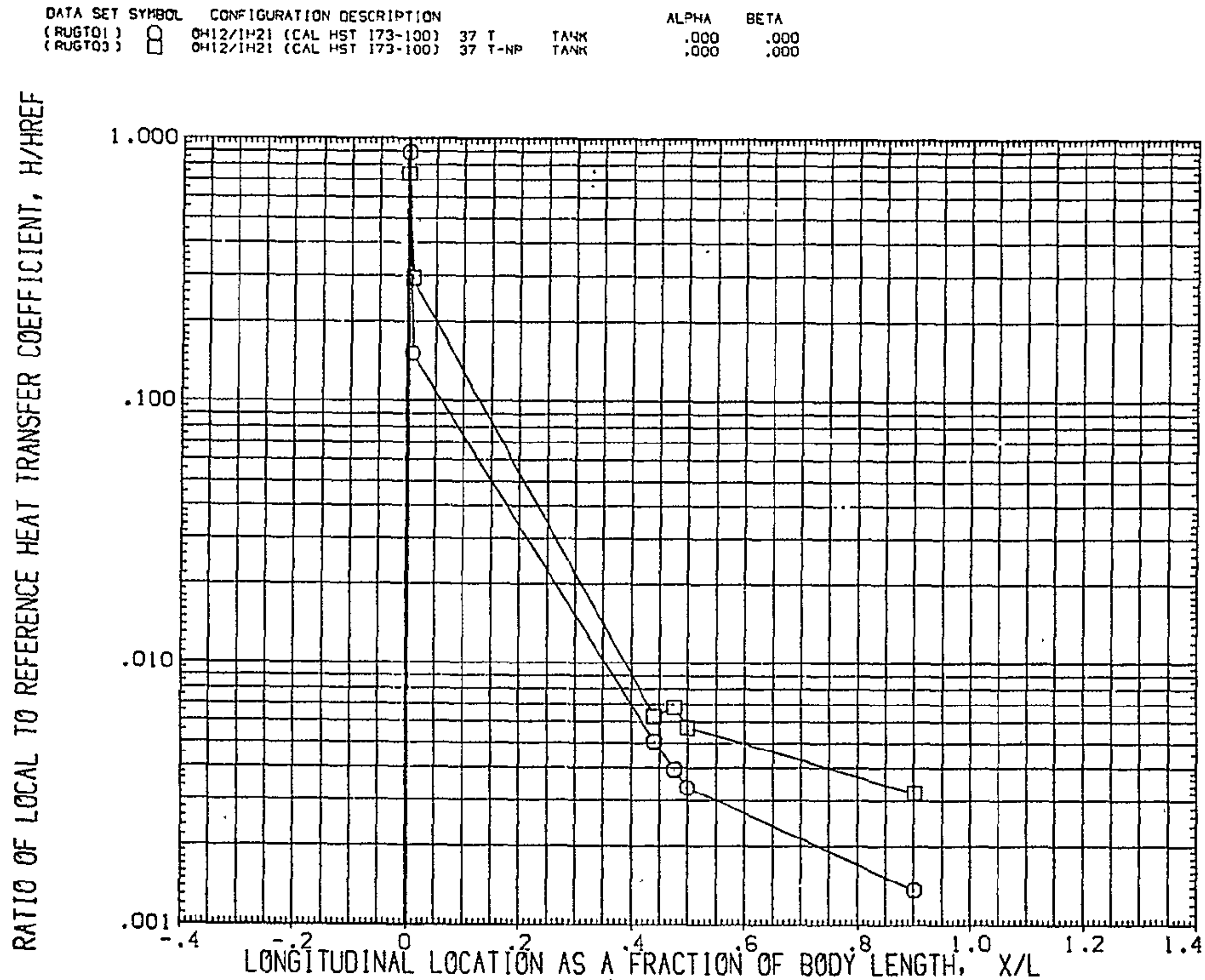

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 199.000

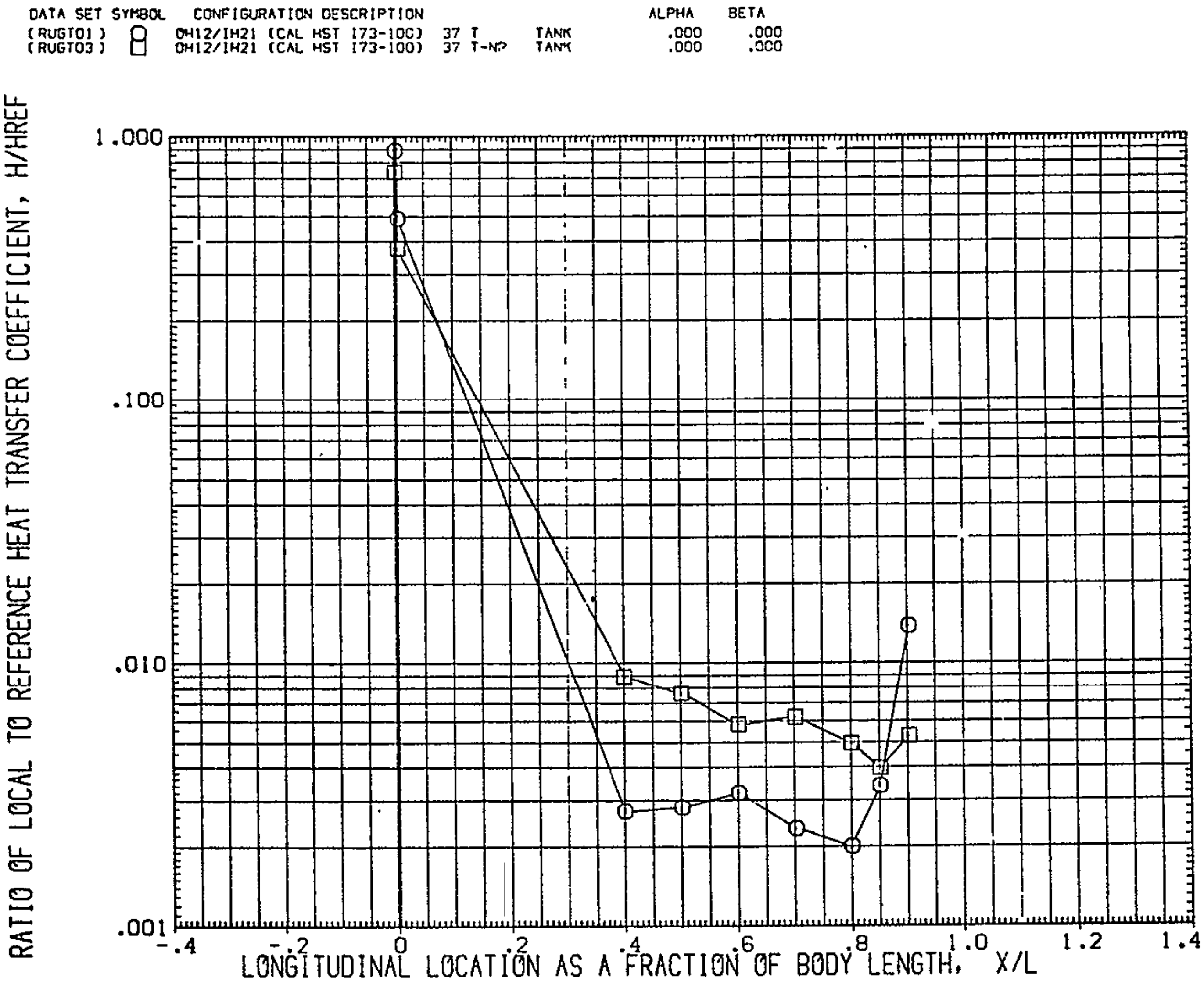

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 221.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	O	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

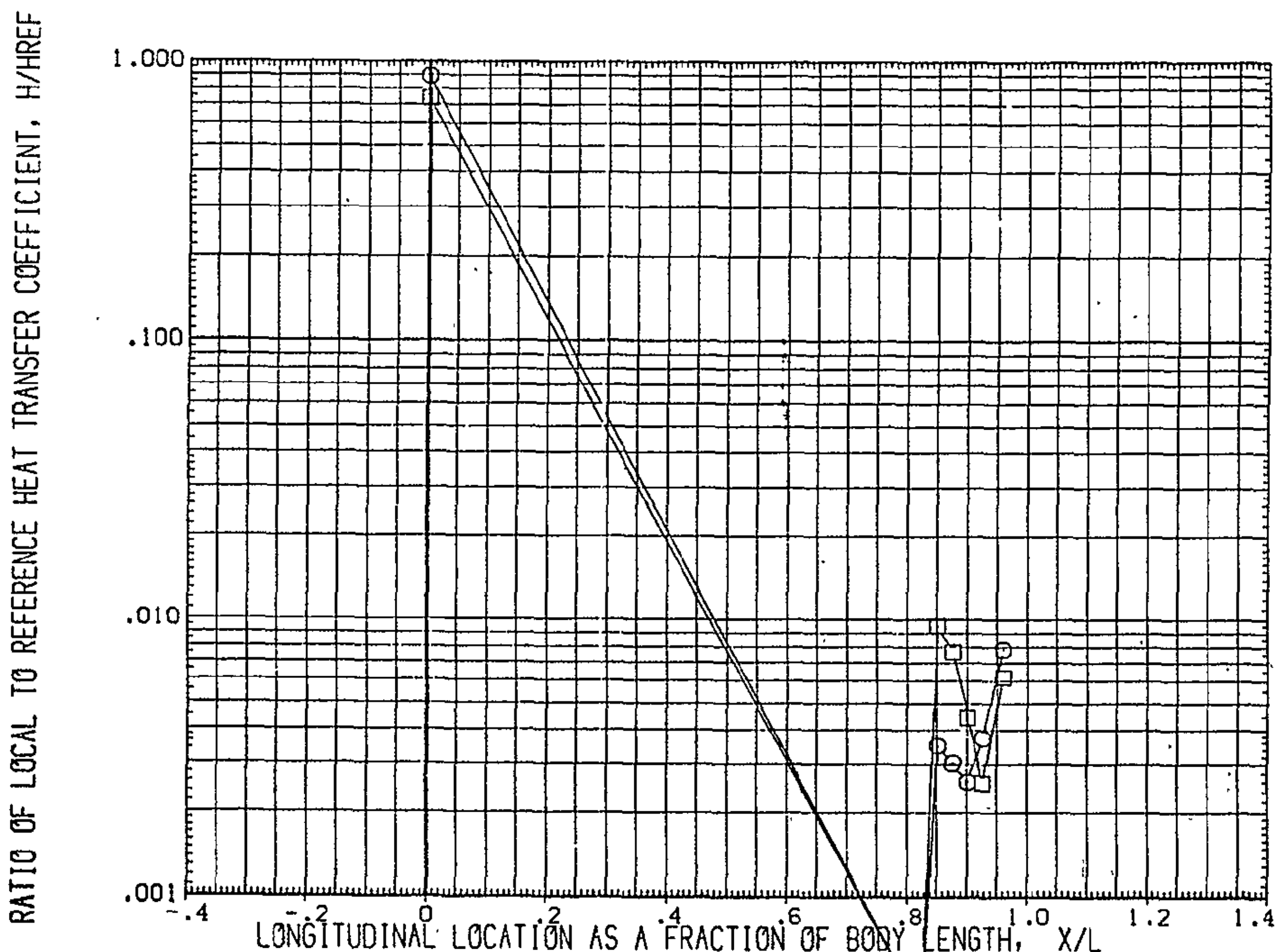

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 241.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

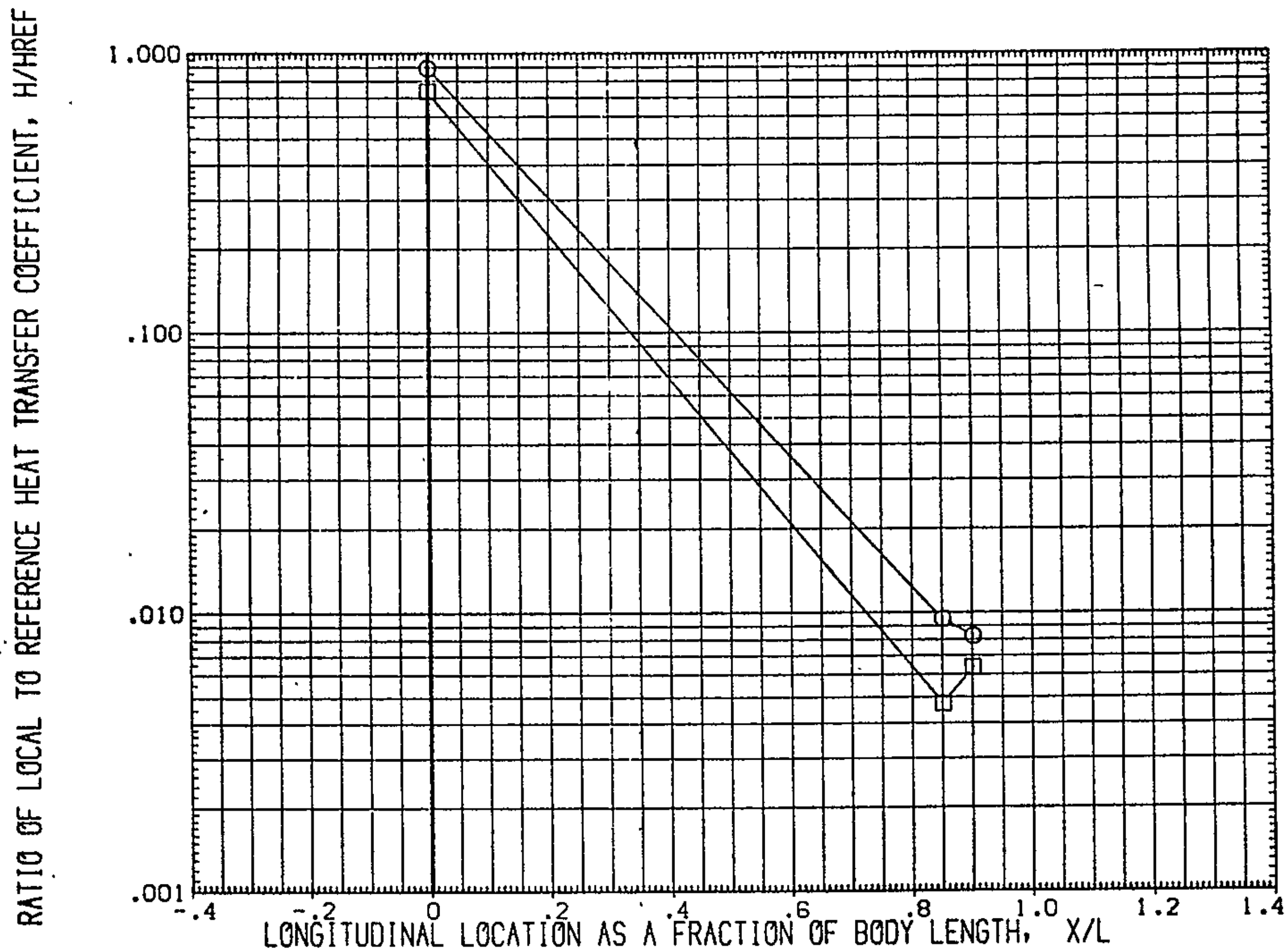

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 247.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

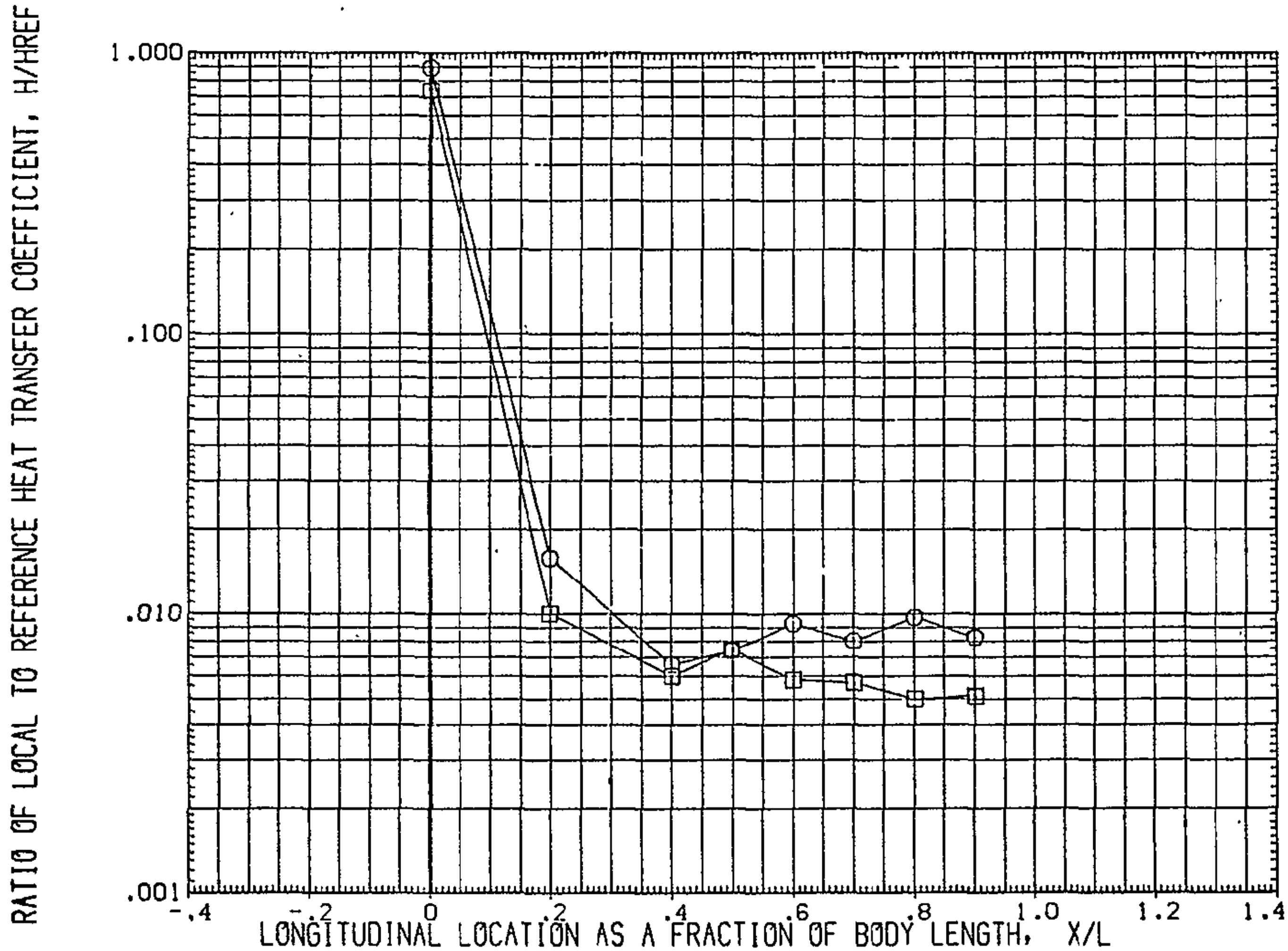

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER · ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 270.000

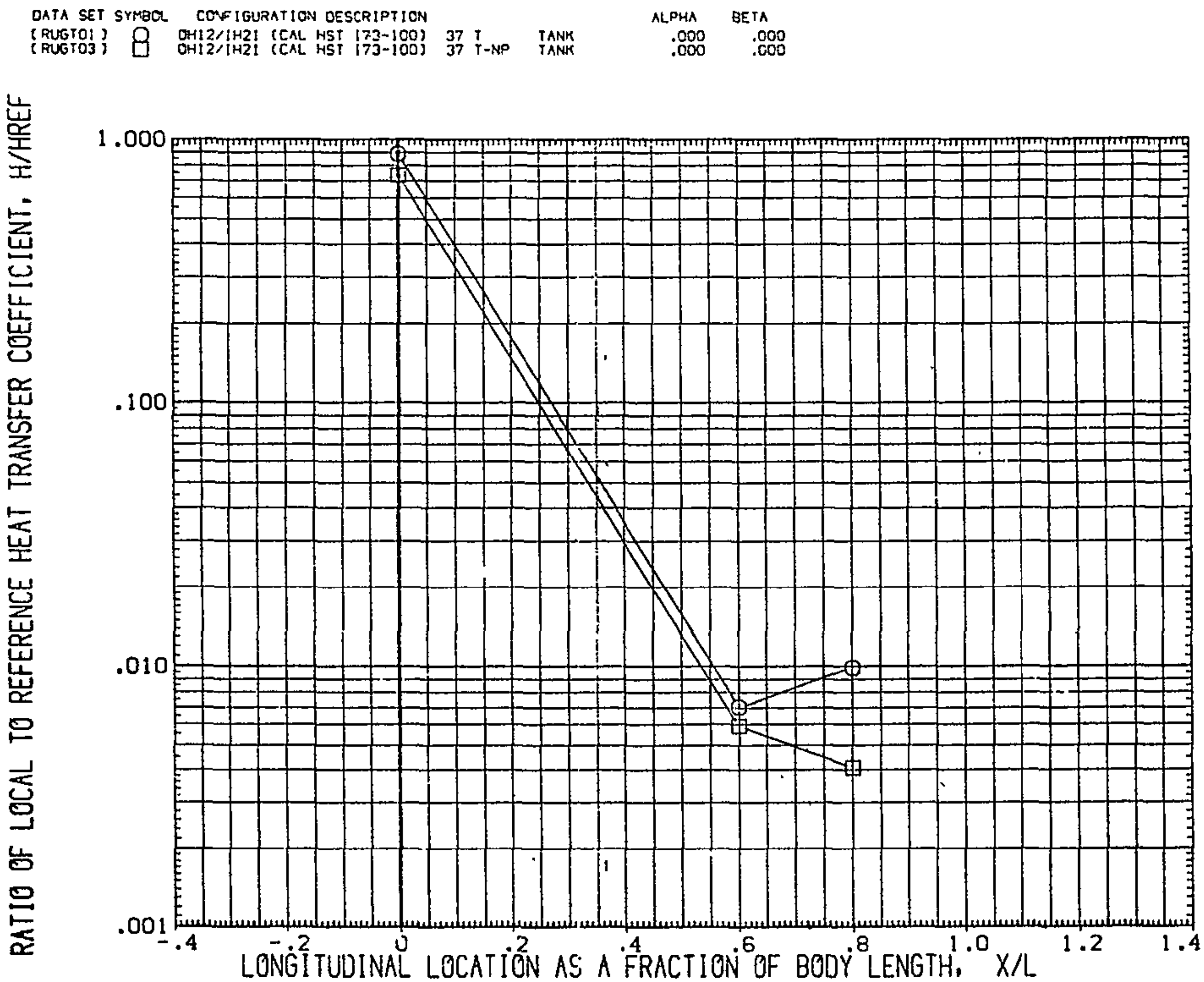

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .850 PHI = 315.000 PAGE 160

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

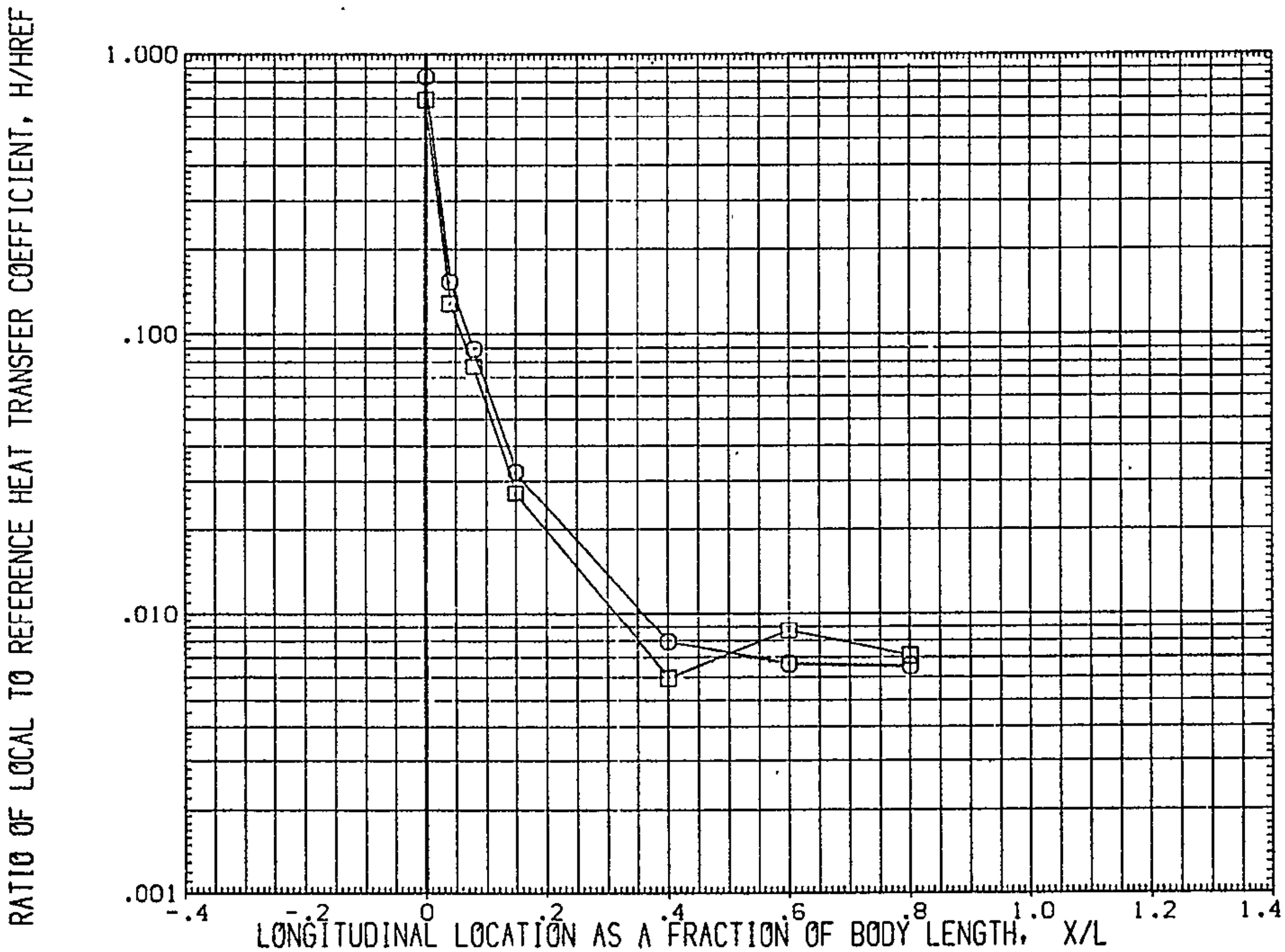

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = .000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	O	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

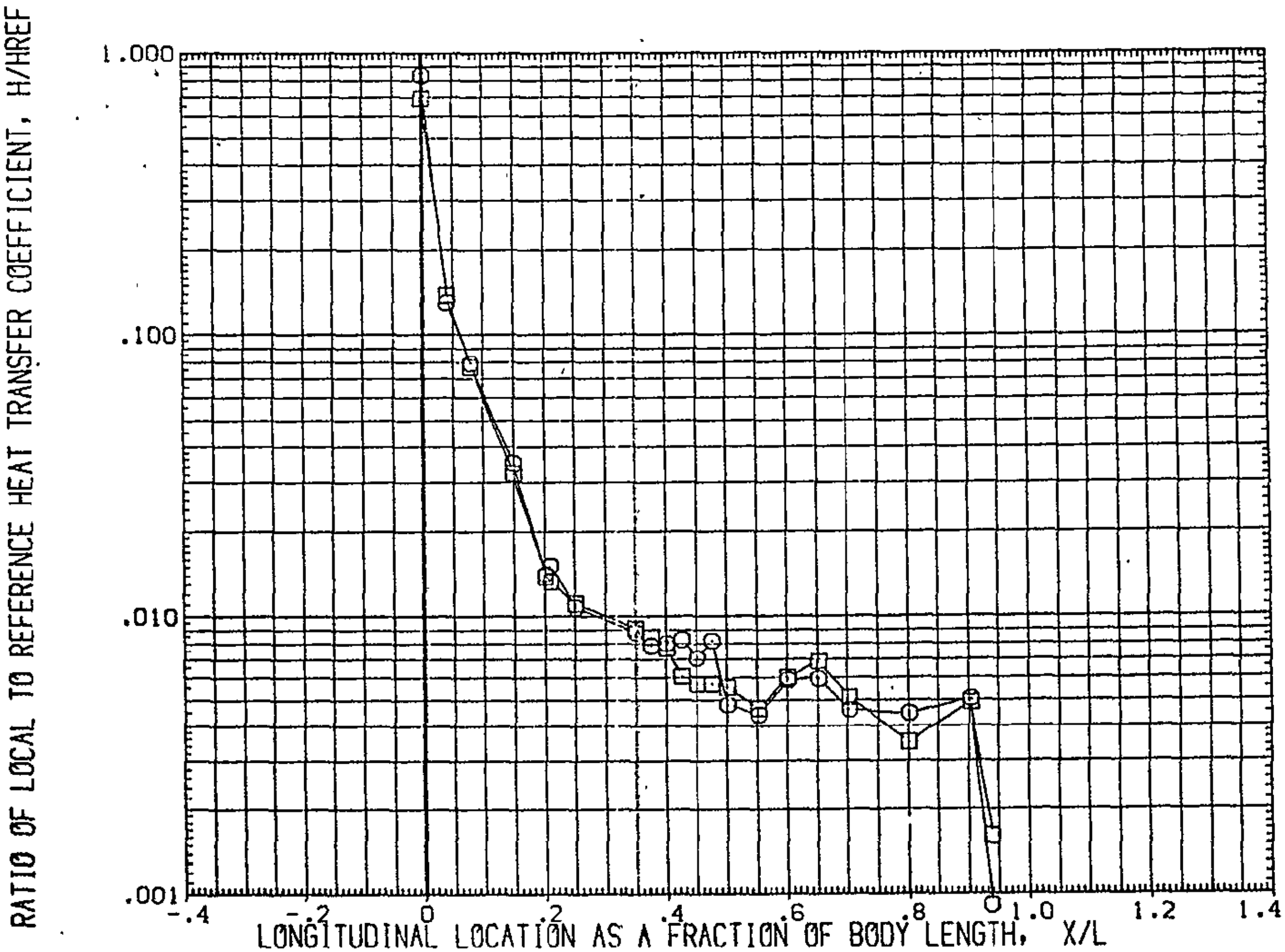

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 180.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST I73-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST I73-100)	37 T-NP	TANK	.000	.000

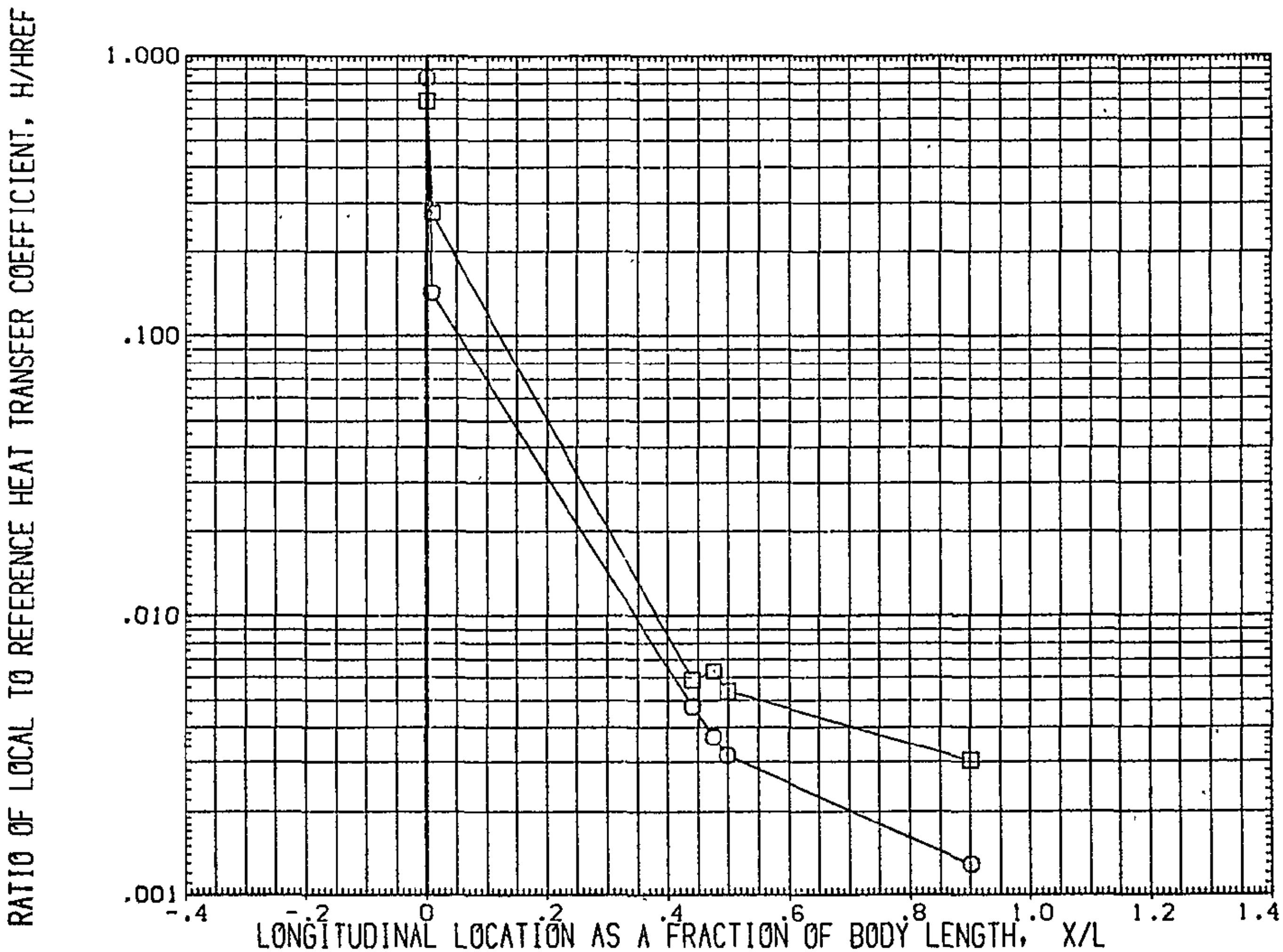

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 199.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION	ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100) 37 T TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100) 37 T-NP TANK	.000	.000

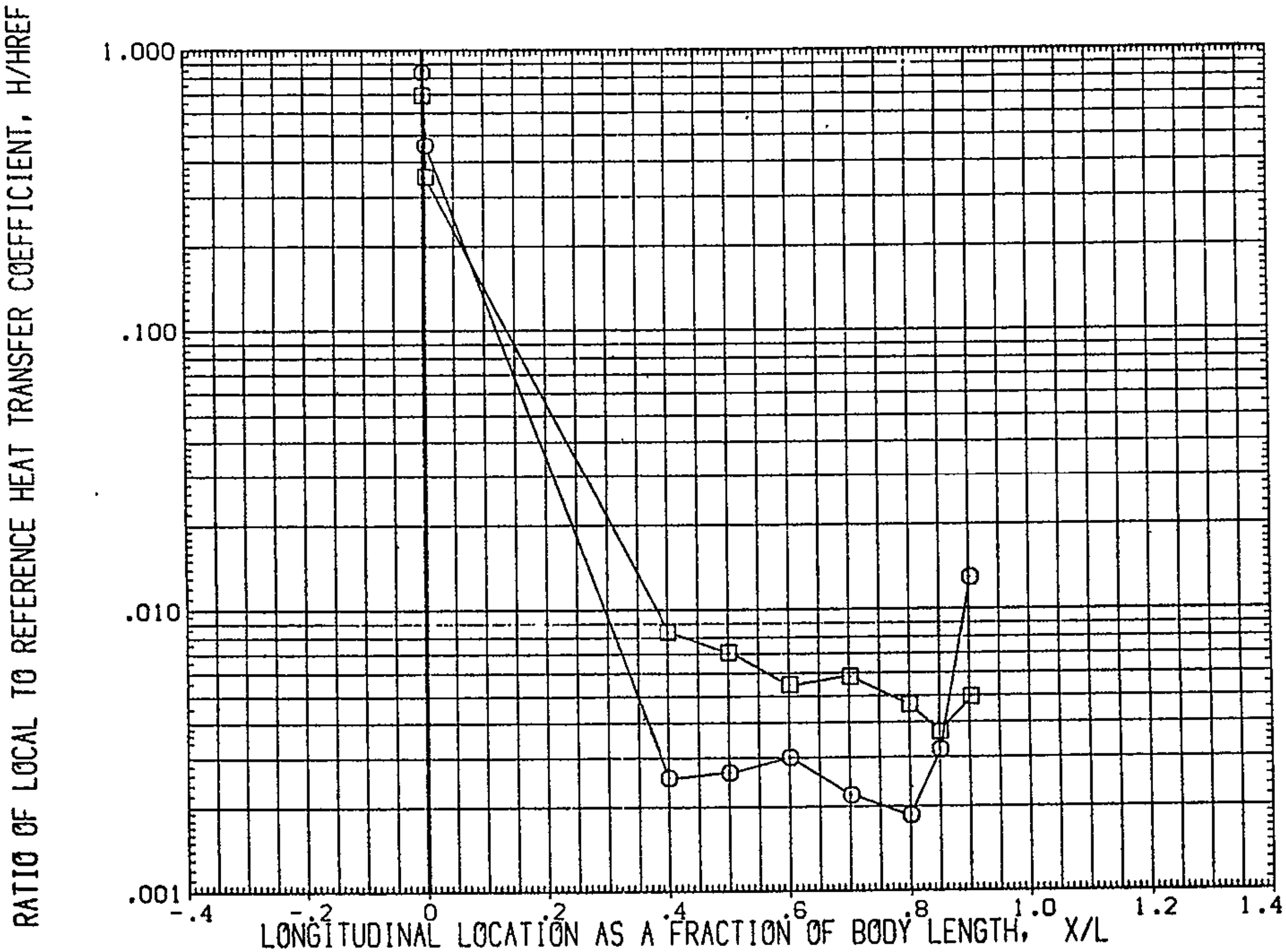

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 221.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION	ALPHA	BETA
(RUGT01)	○	0H12/IH21 (CAL HST 173-100) 37 T TANK	.000	.000
(RUGT03)	□	0H12/IH21 (CAL HST 173-100) 37 T-NP TANK	.000	.000

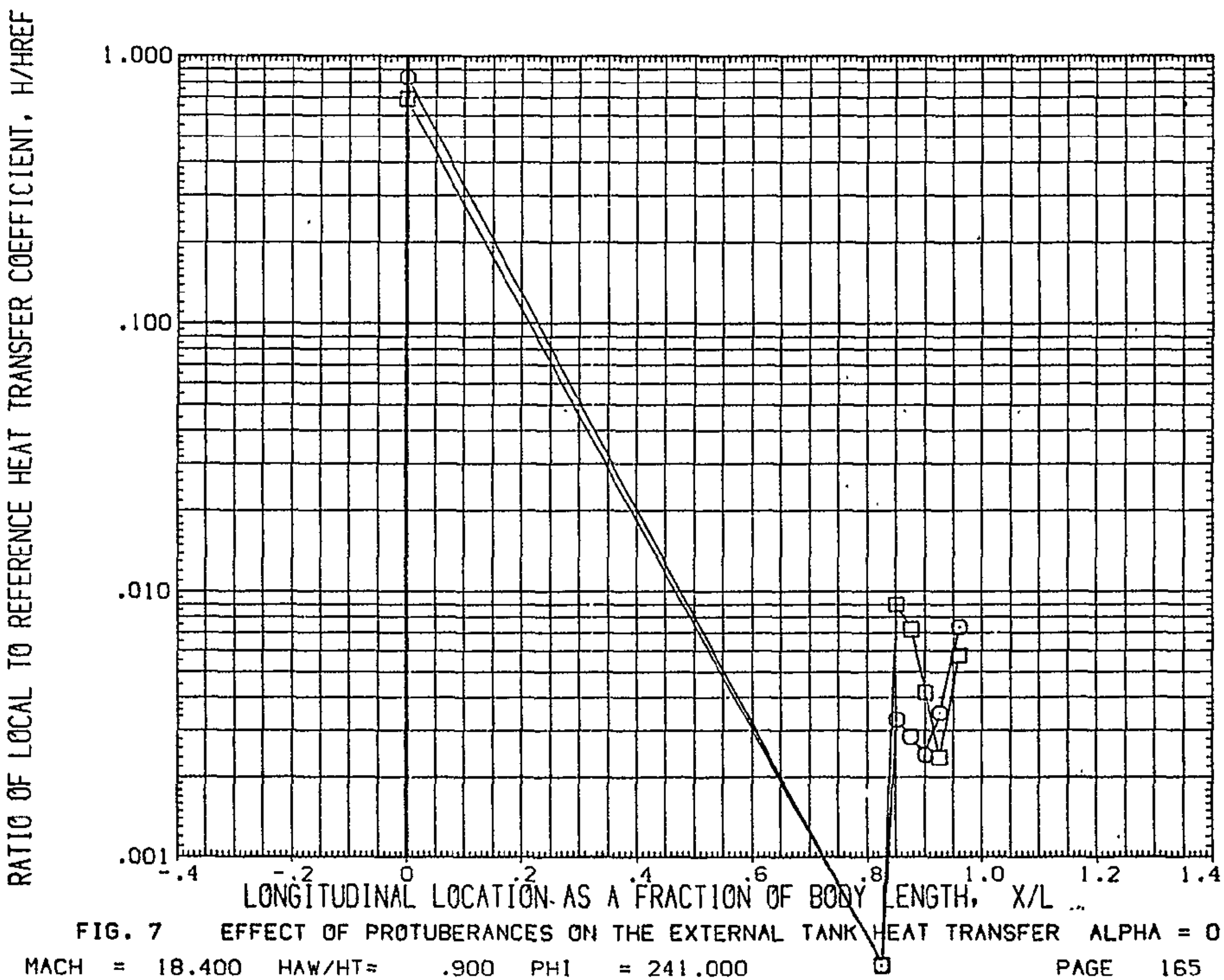

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 241.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

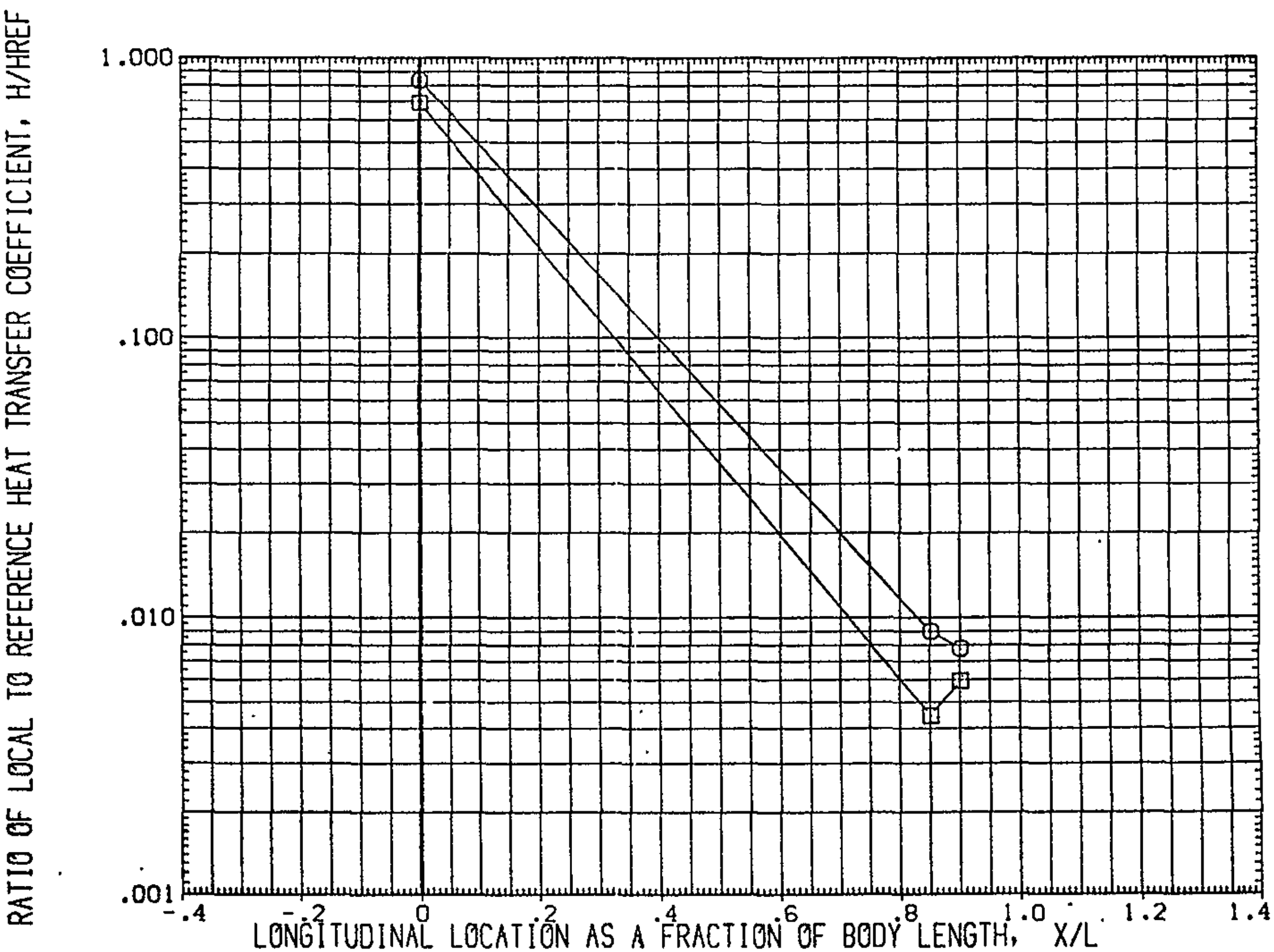

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 247.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION	ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100) 37 T TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100) 37 T-NP TANK	.000	.000

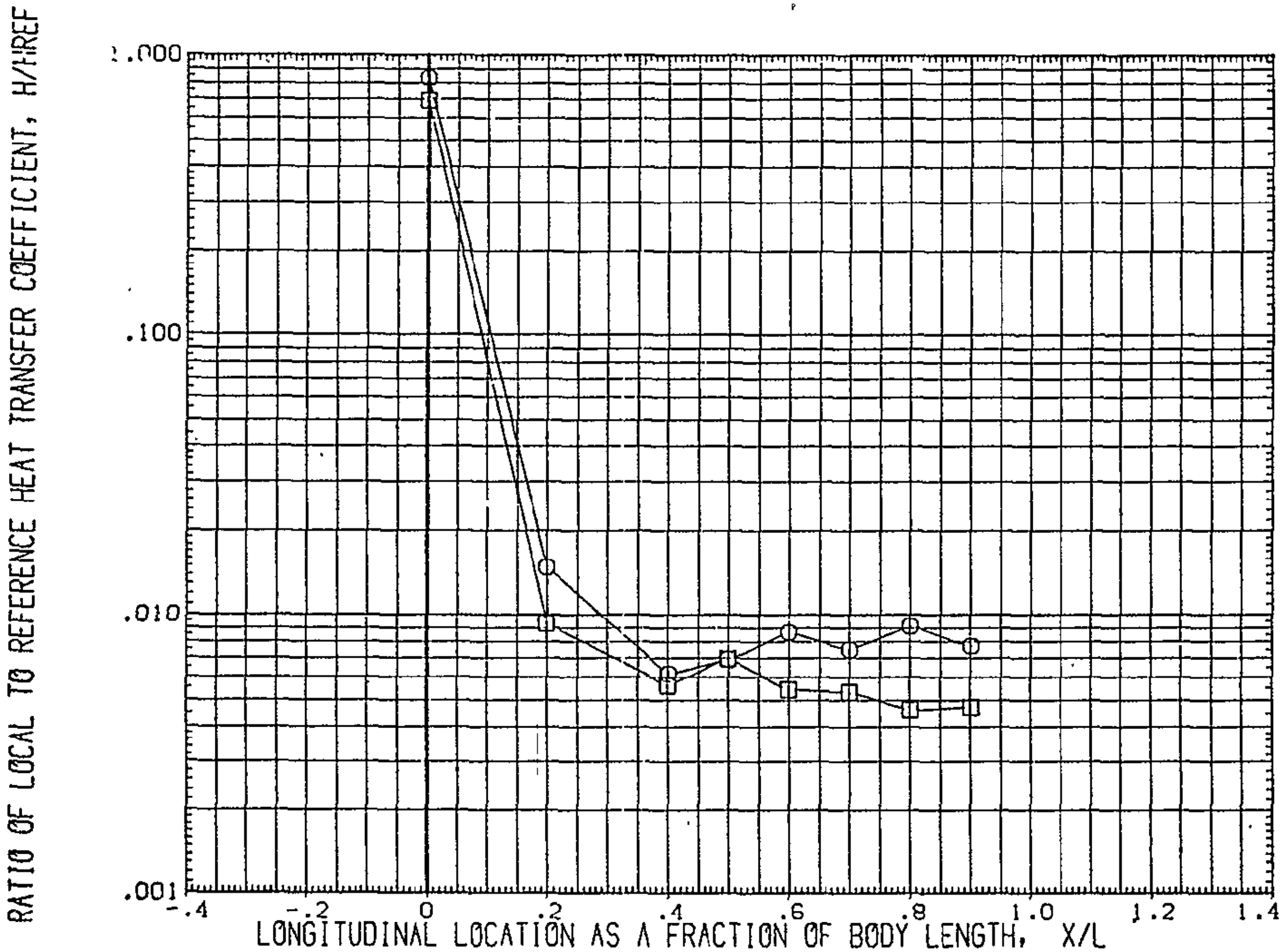

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 270.000

DATA SET SYMBOL CONFIGURATION DESCRIPTION ALPHA BETA
(RUGT01) ○ OH12/IH21 (CAL HST 173-100) 37 T TANK .000 .000
(RUGT03) □ OH12/IH21 (CAL HST 173-100) 37 T-NP TANK .000 .000

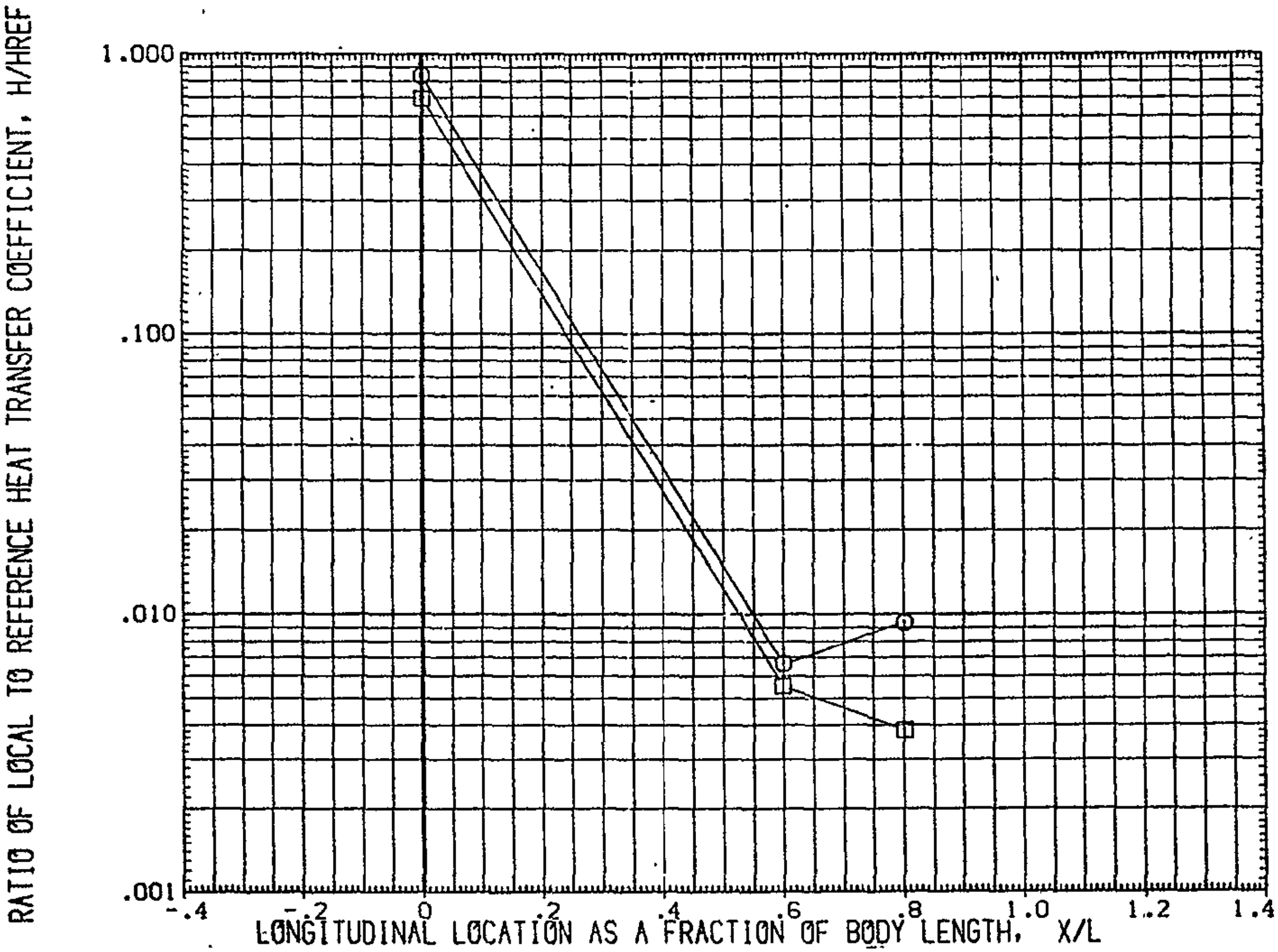

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= .900 PHI = 315.000

DATA SET SYMBOL CONFIGURATION DESCRIPTION ALPHA BETA
(RUGT01) ○ OH12/IH21 (CAL HST [73-100) 37 T TANK .000 .000
(RUGT03) □ OH12/IH21 (CAL HST [73-100) 37 T-NP TANK .000 .000

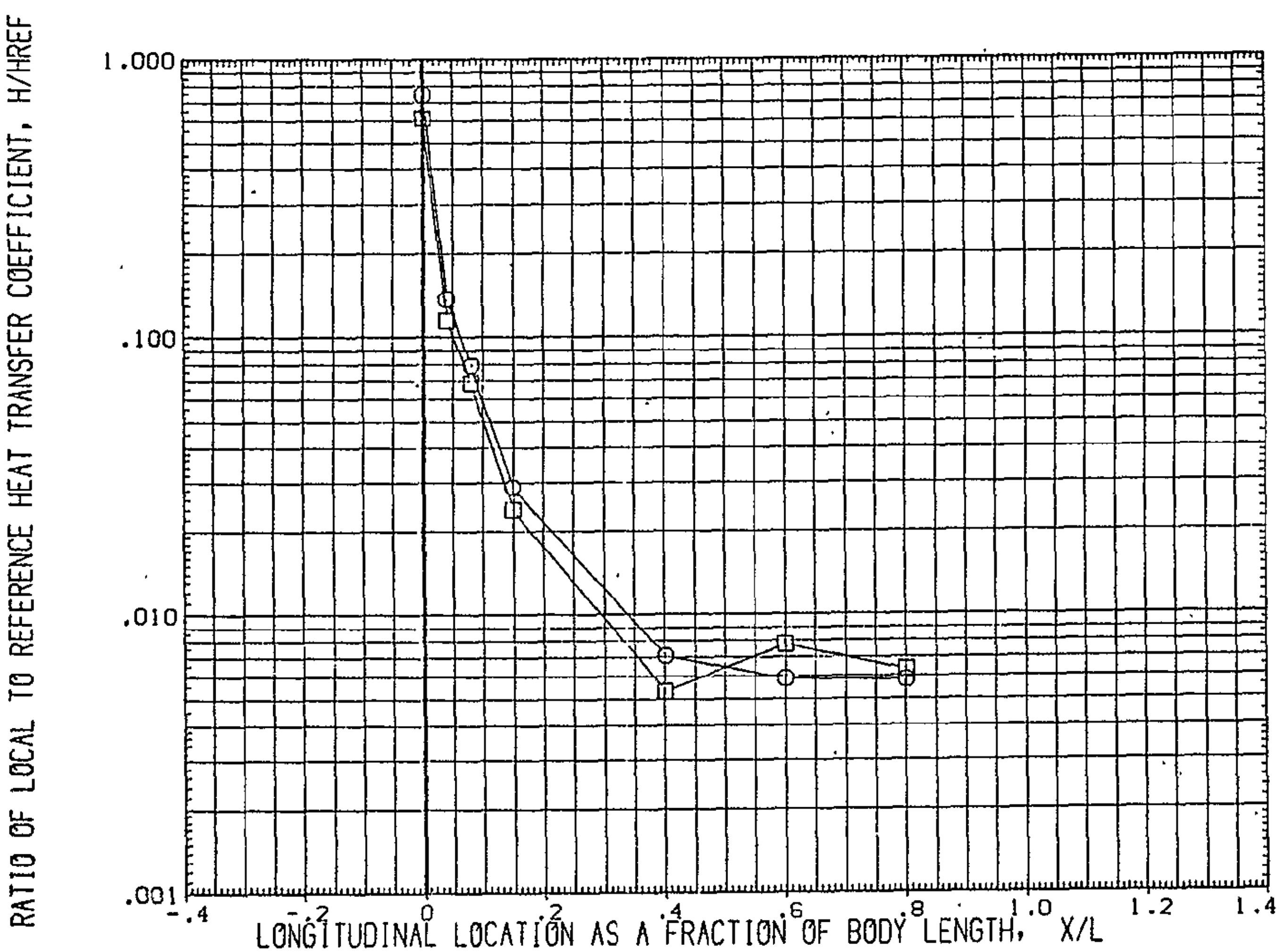

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = .000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

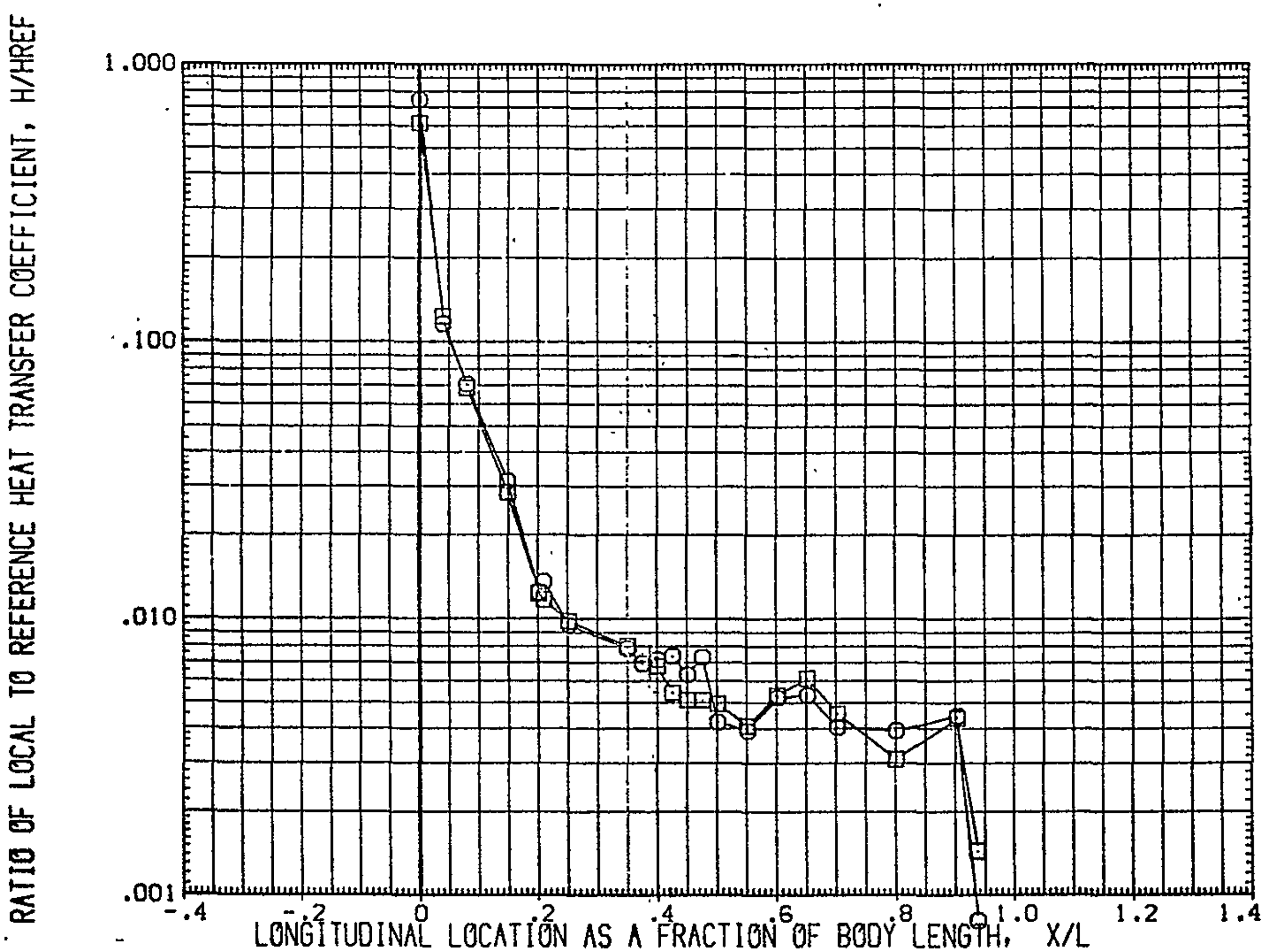

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 180.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

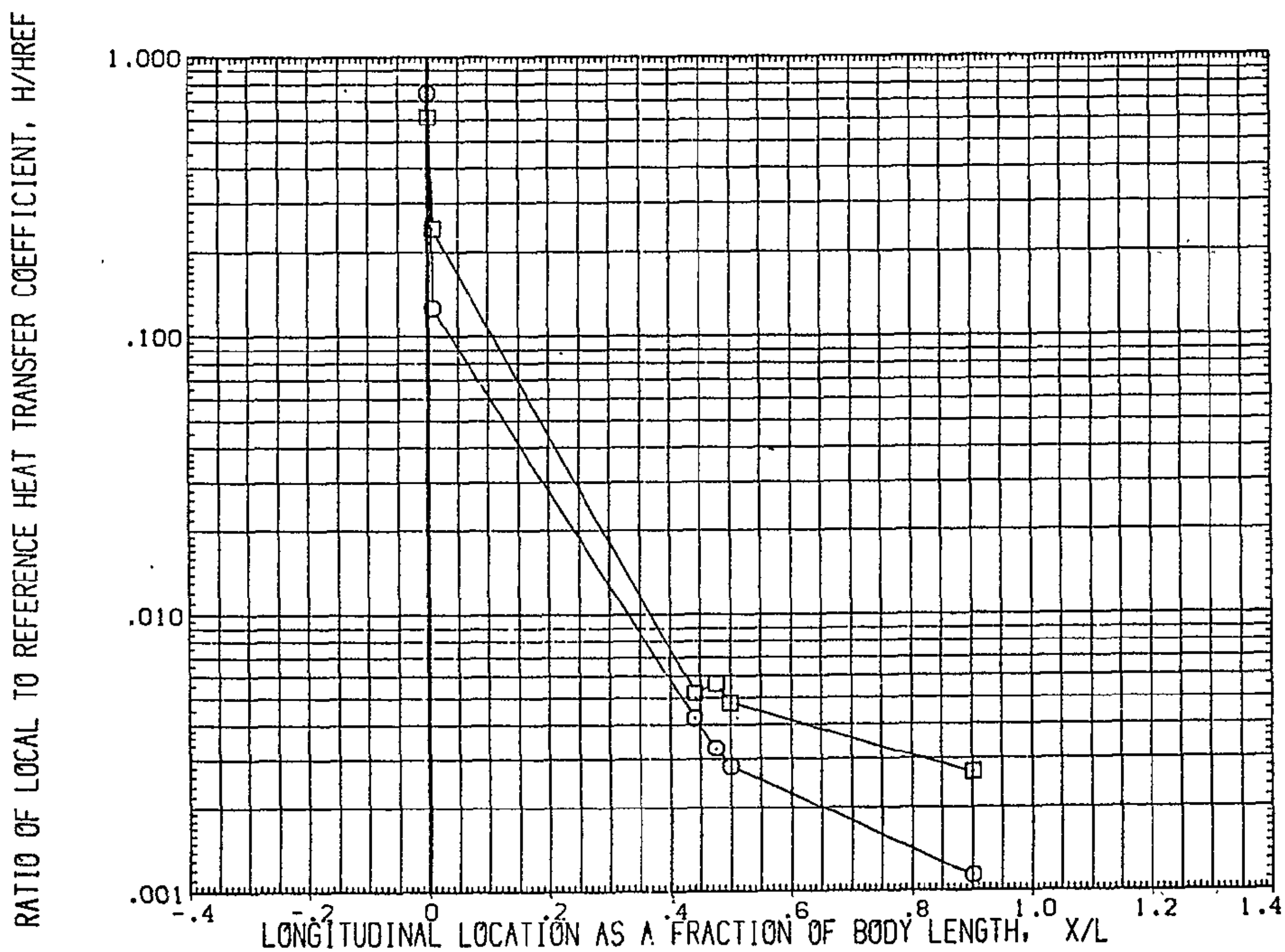

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 199.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	CH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

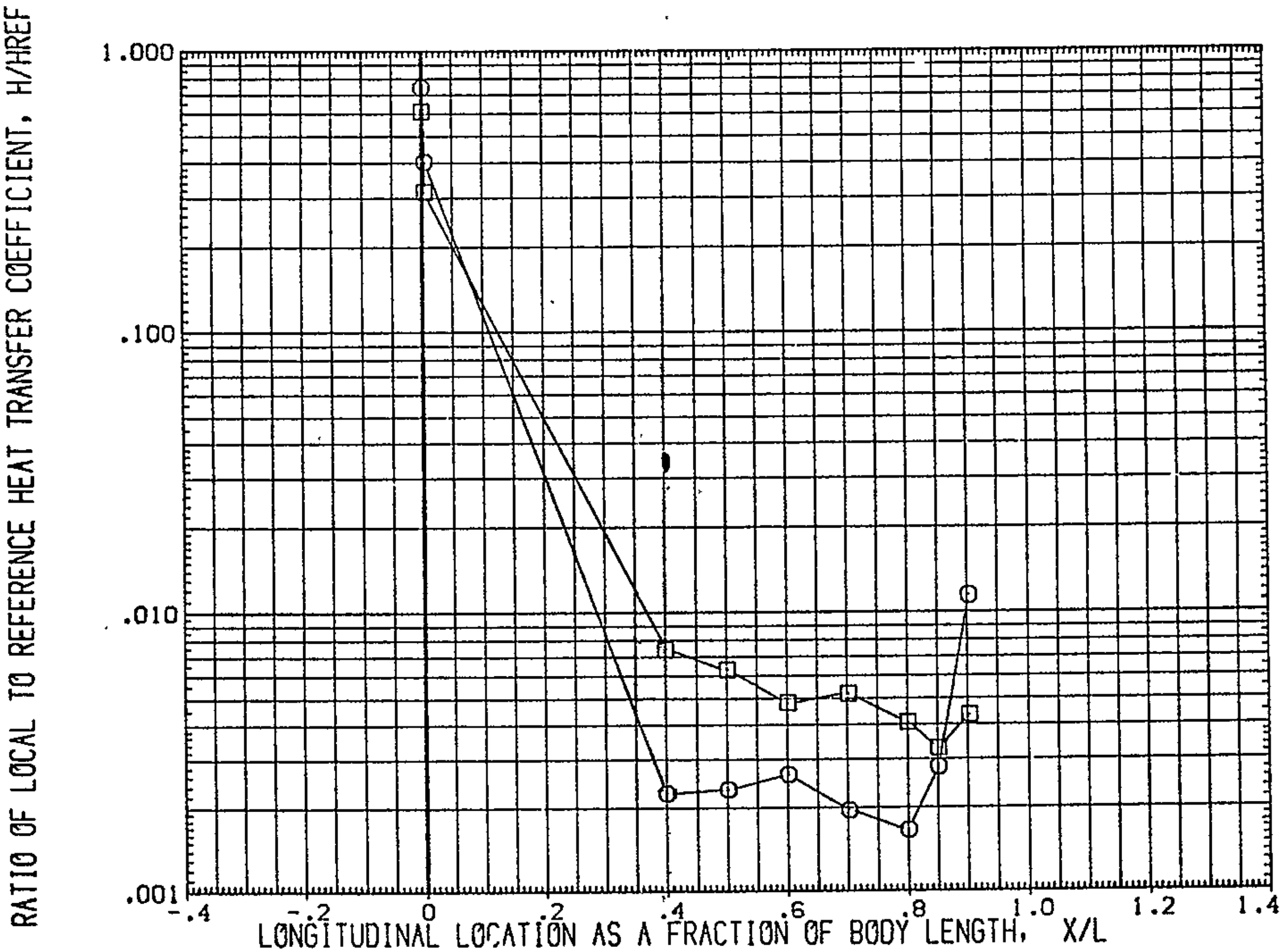

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 221.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST (73-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST (73-100)	37 T-NP	TANK	.000	.000

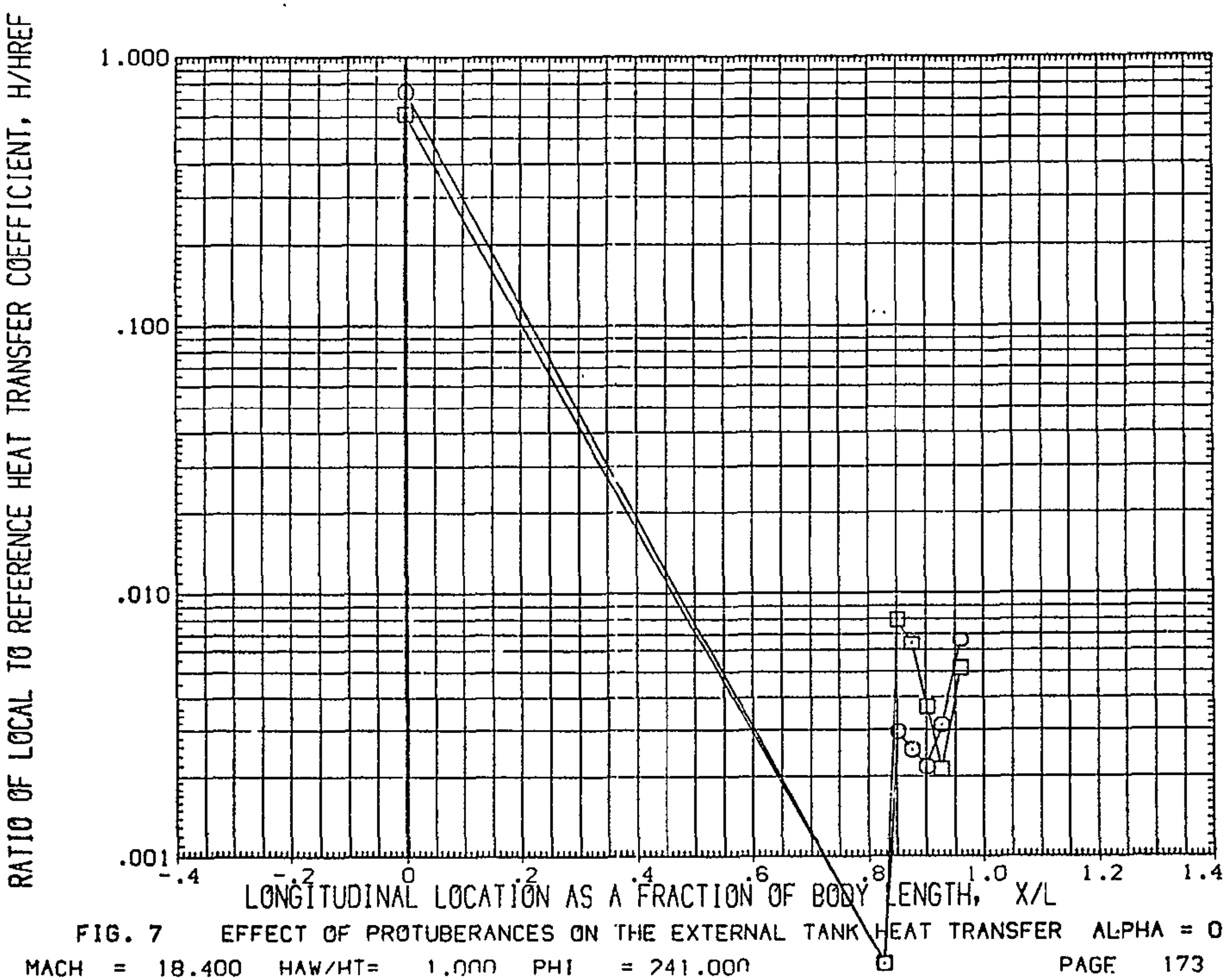

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 241.000

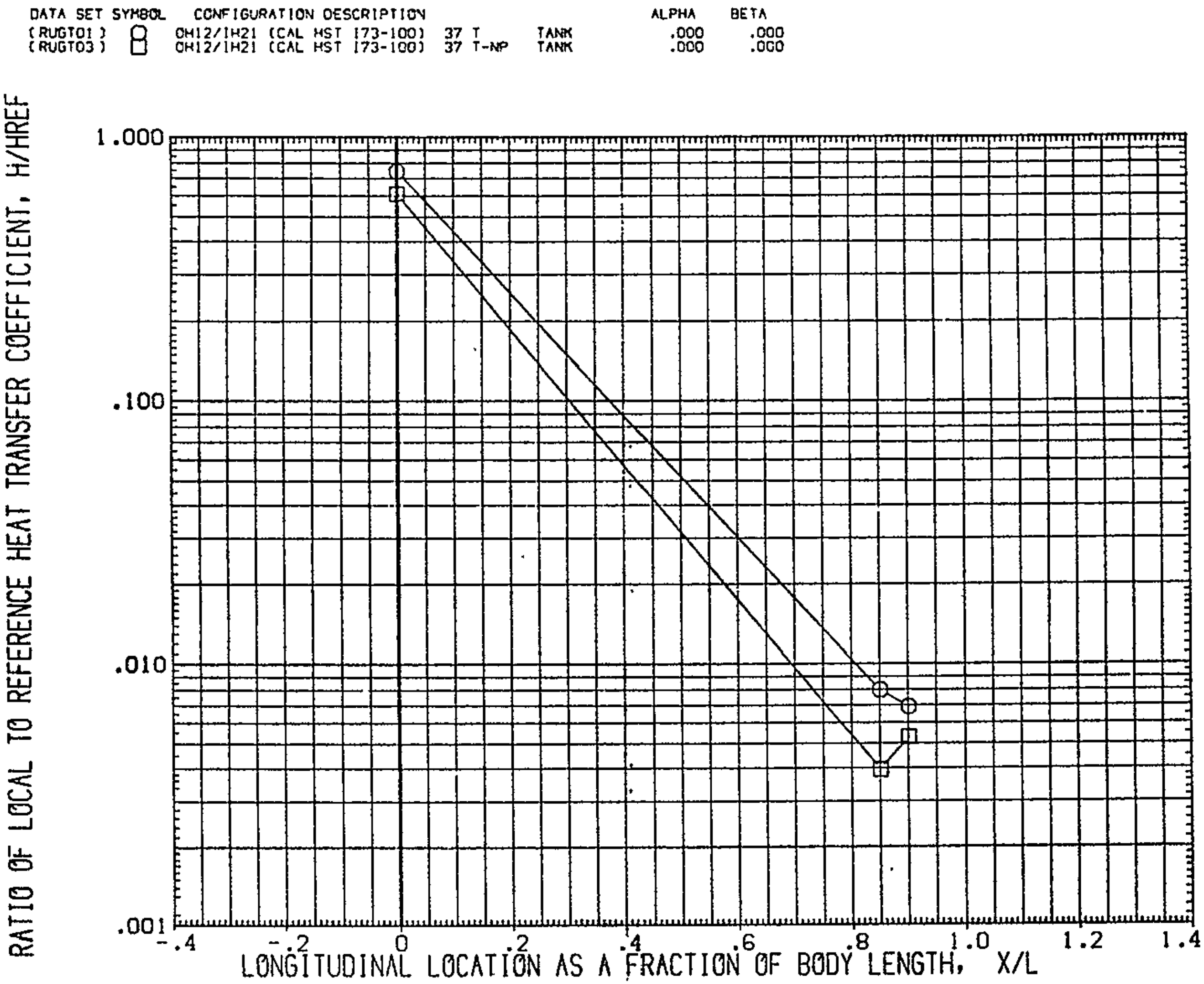

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 247.000

DATA SET	SYMBOL	CONFIGURATION DESCRIPTION			ALPHA	BETA
(RUGT01)	○	OH12/IH21 (CAL HST 173-100)	37 T	TANK	.000	.000
(RUGT03)	□	OH12/IH21 (CAL HST 173-100)	37 T-NP	TANK	.000	.000

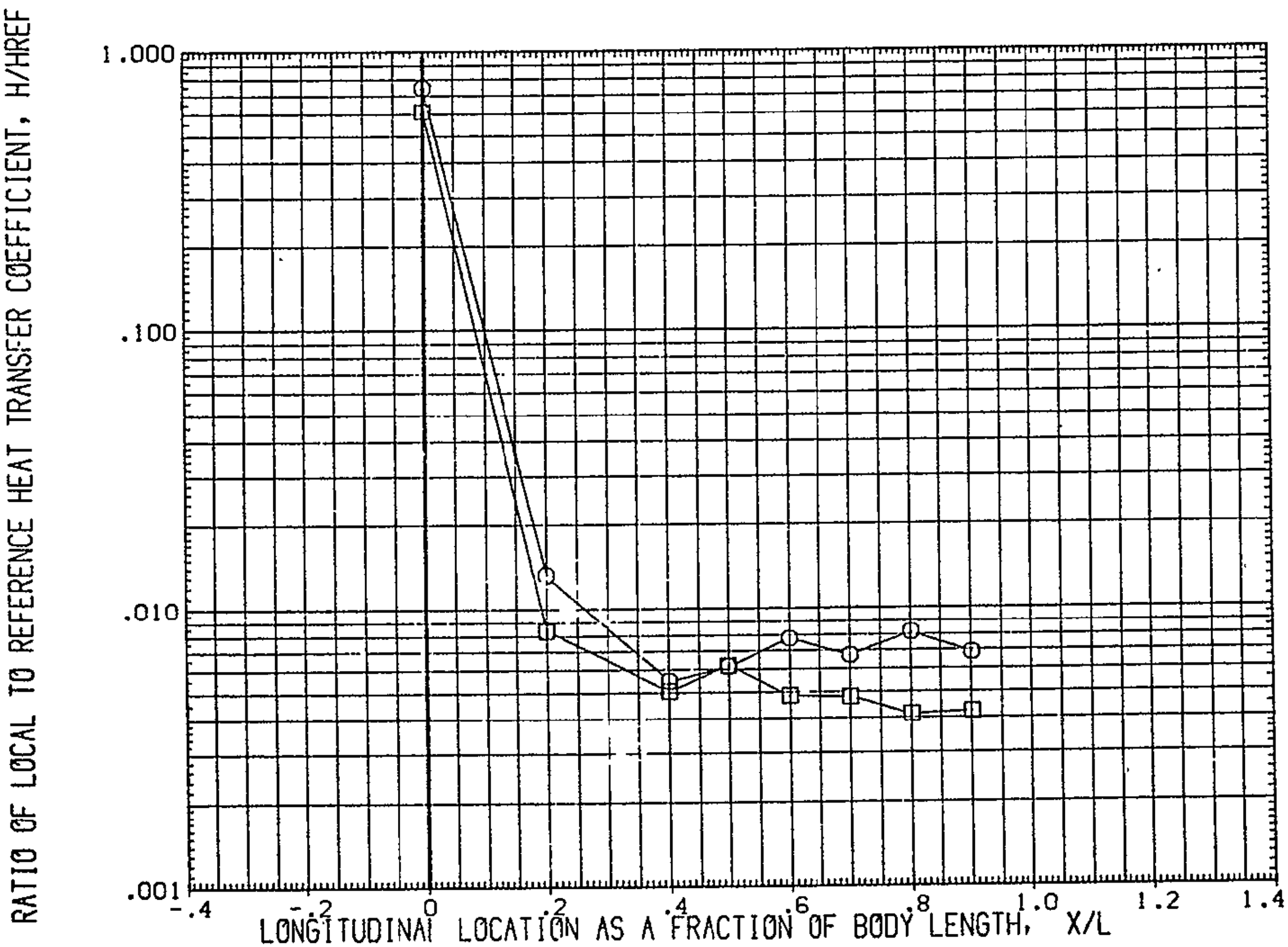

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 270.000

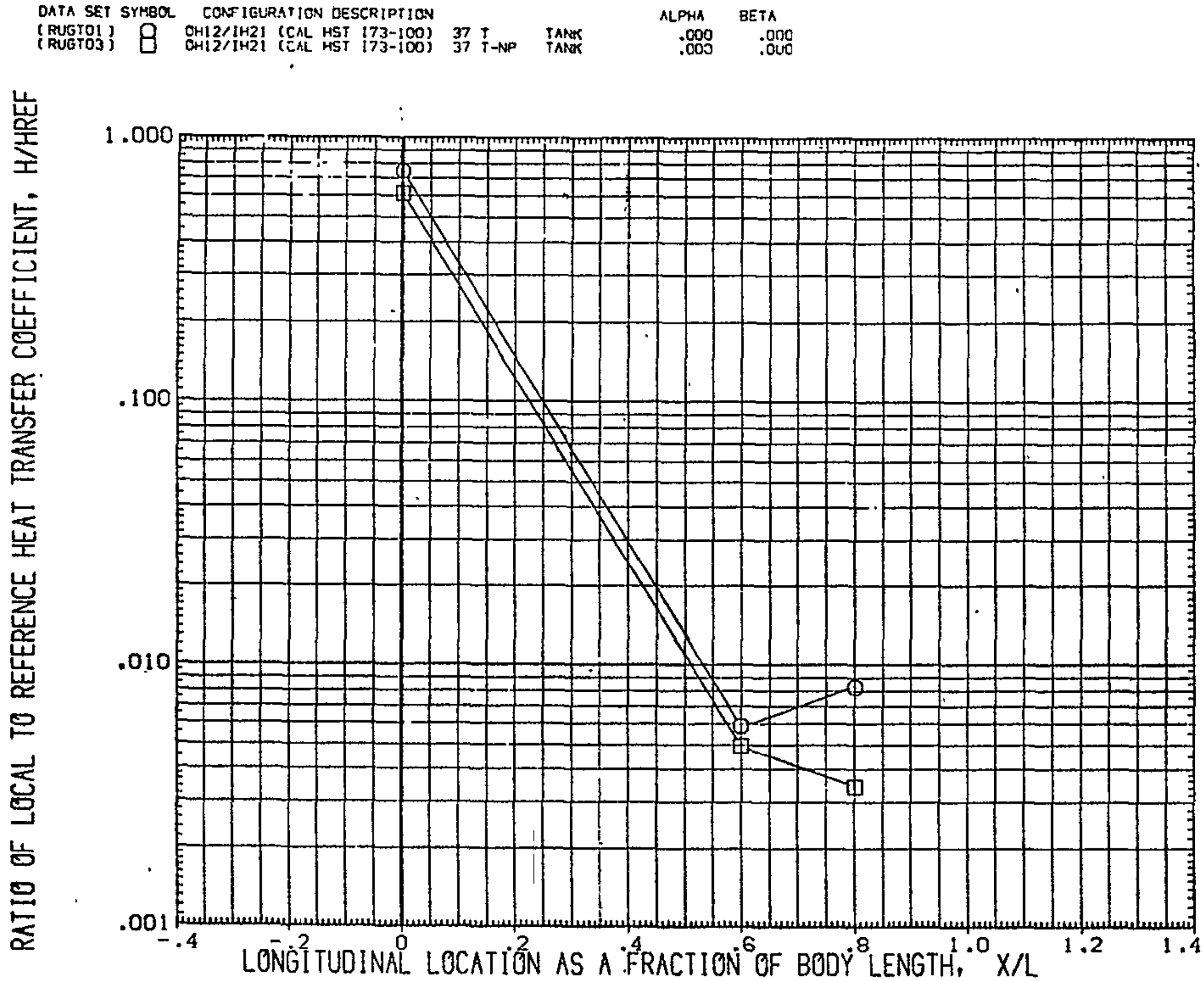

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

MACH = 18.400 HAW/HT= 1.000 PHI = 315.000

OH12 + IH21 MODEL 37 T(01)/T-NP(03) TANK (IUGT01)

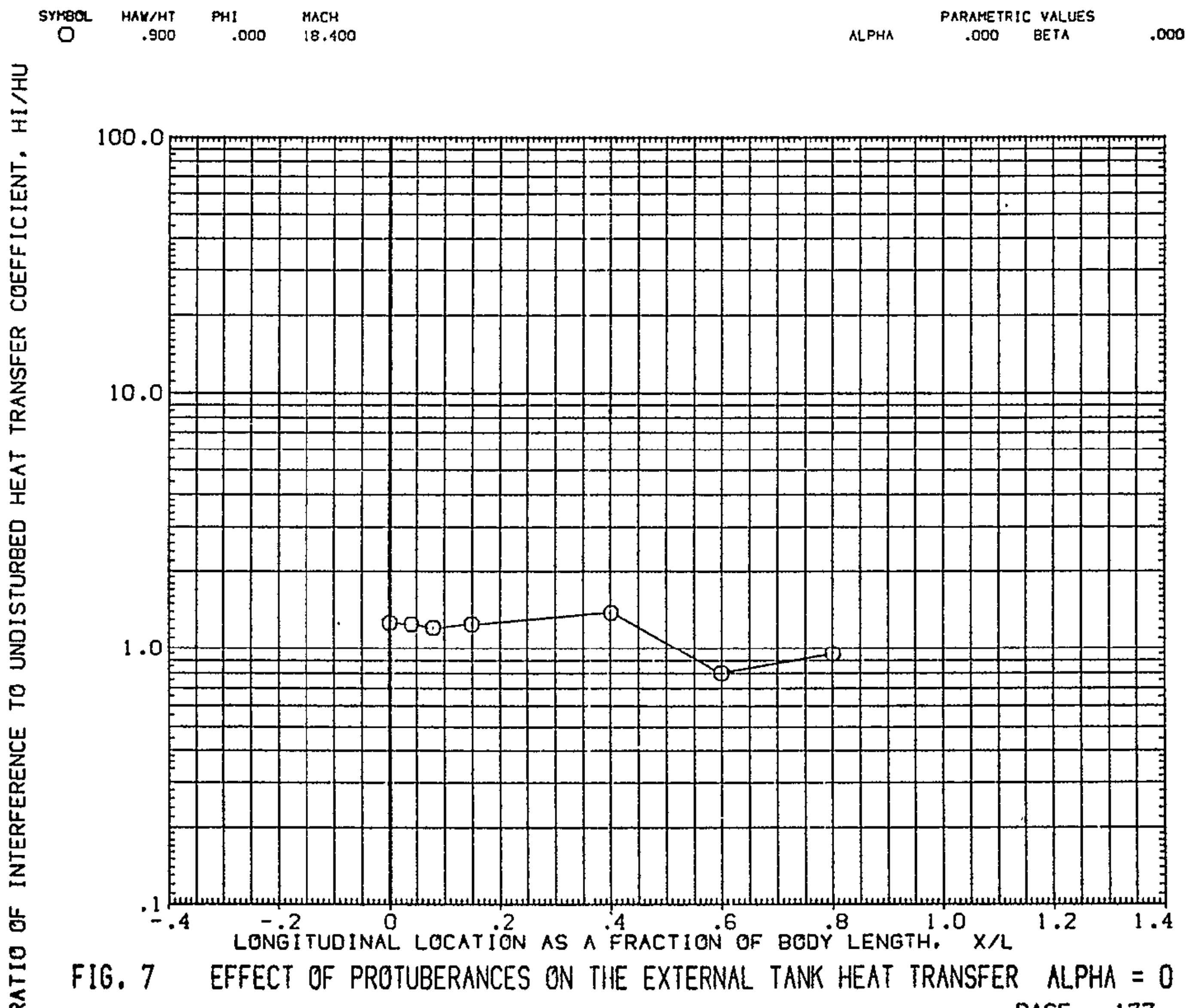

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 T(01)/T-NP(03) TANK (IUGT01)

SYMBOL	HAW/HT	PHI	MACH
O	.900	180.000	18.400

PARAMETRIC VALUES

ALPHA .000 BETA .000

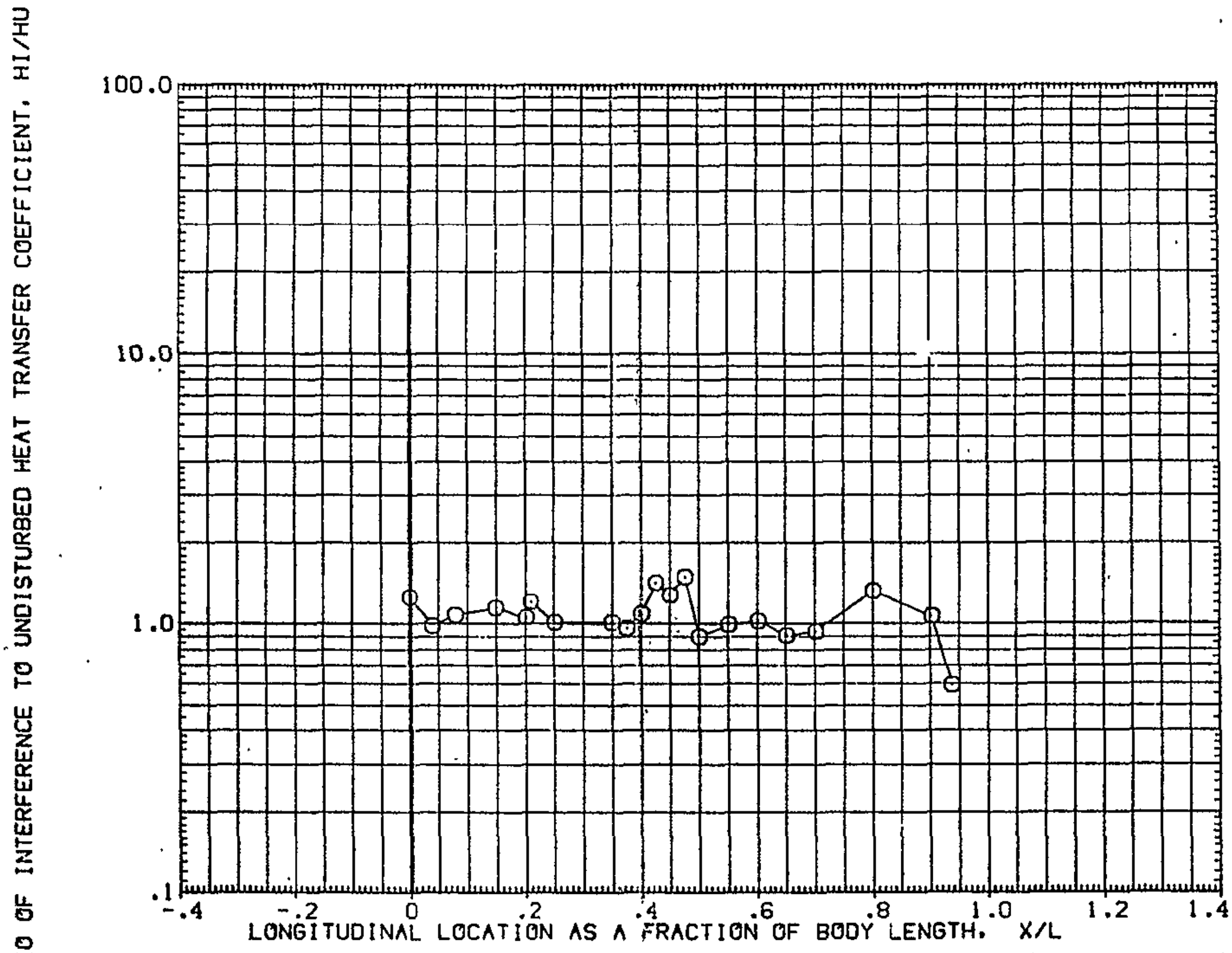

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

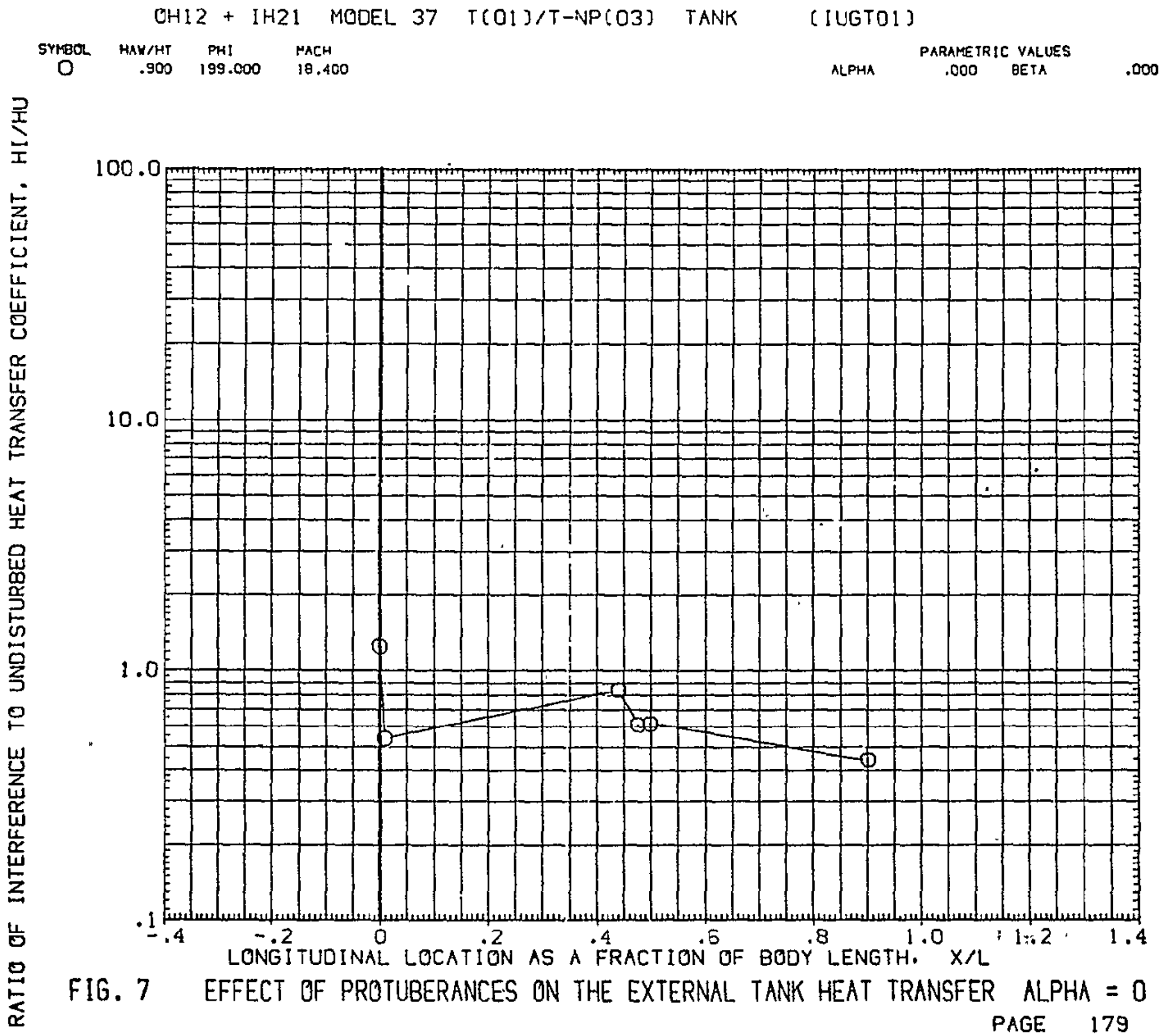

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

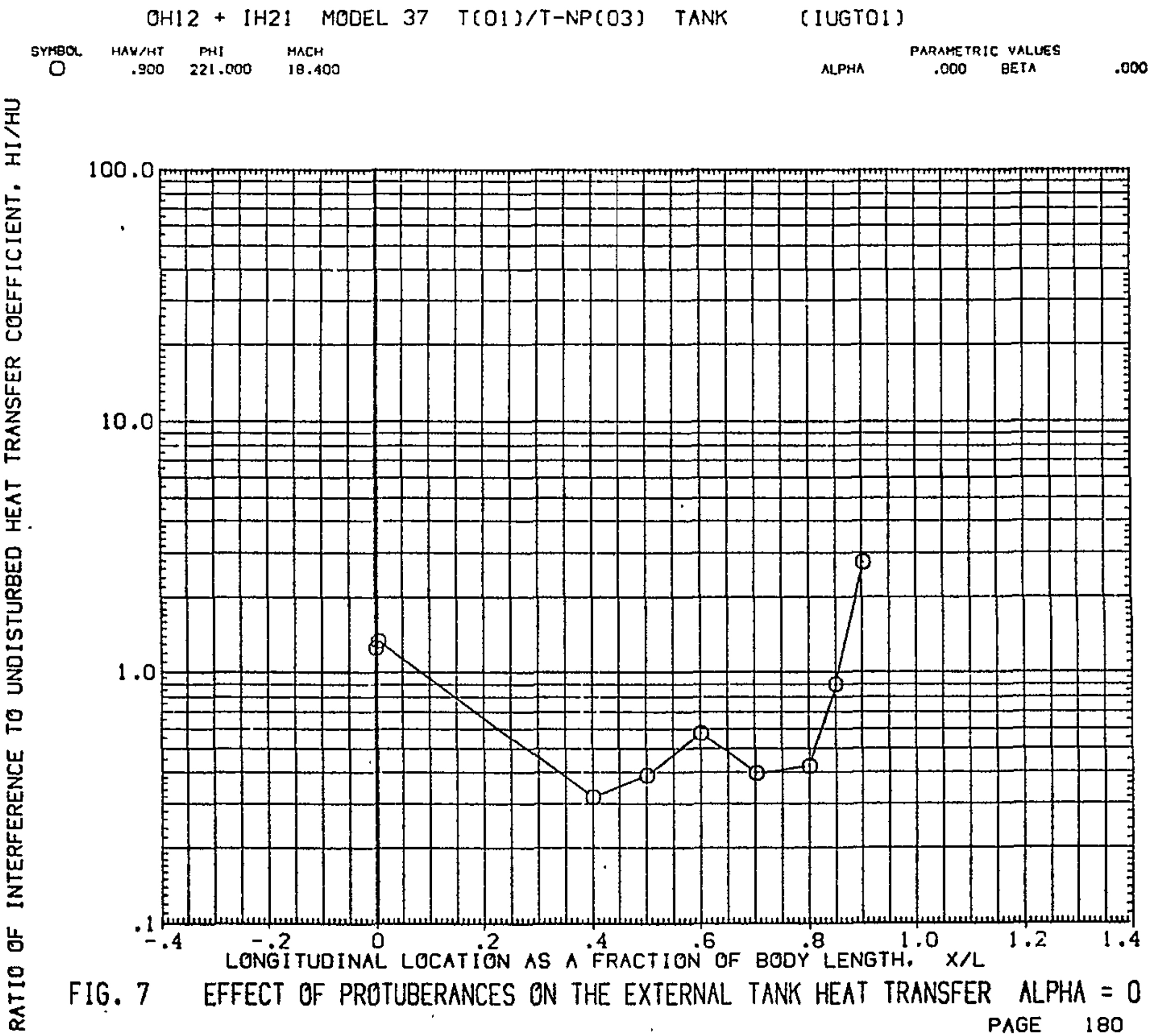

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 T(01)/T-NP(03) TANK (IUGT01)

SYMBOL	HAW/HT	PHI	MACH
O	.900	241.000	18.400

PARAMETRIC VALUES

ALPHA .000 BETA .000

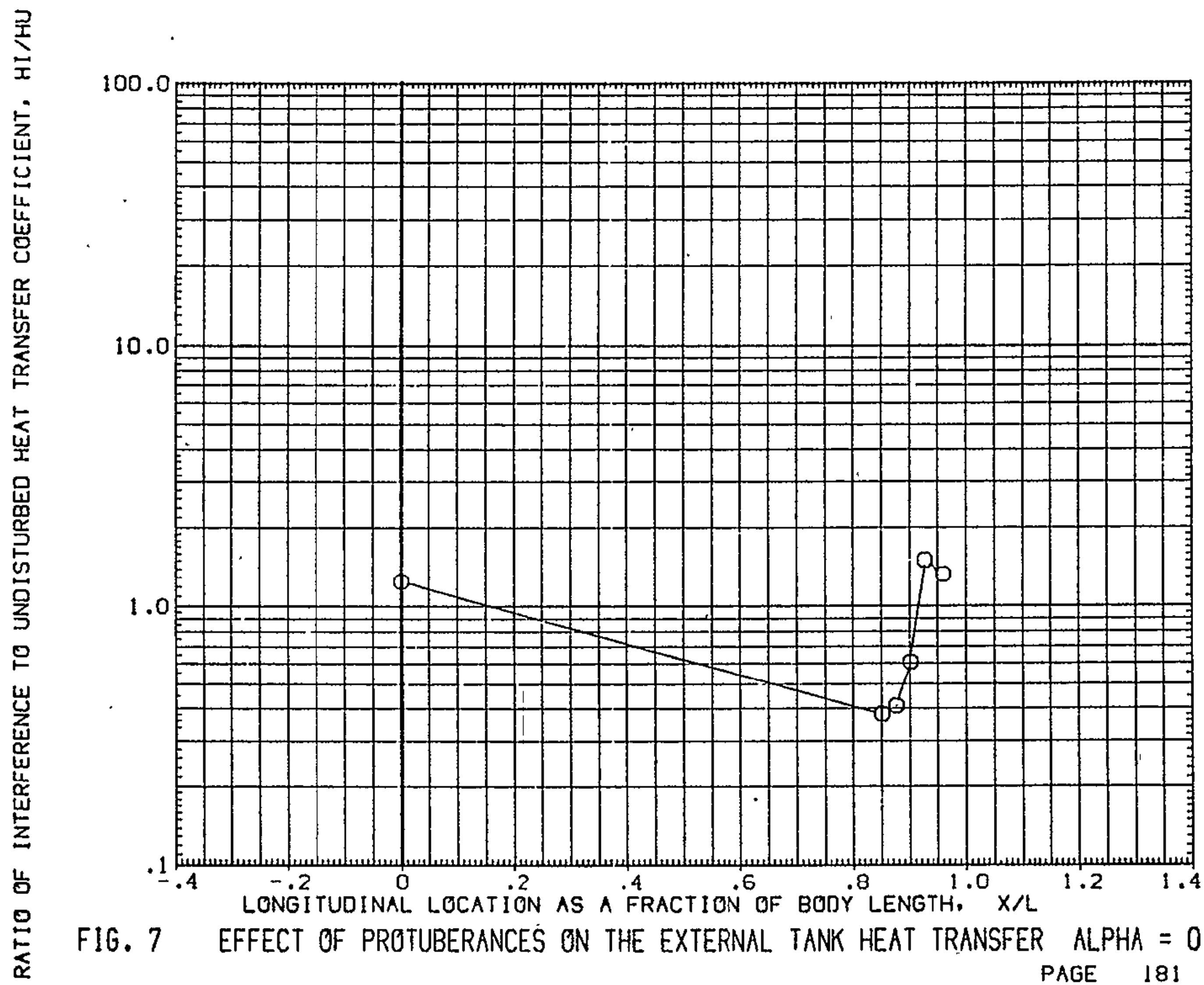

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

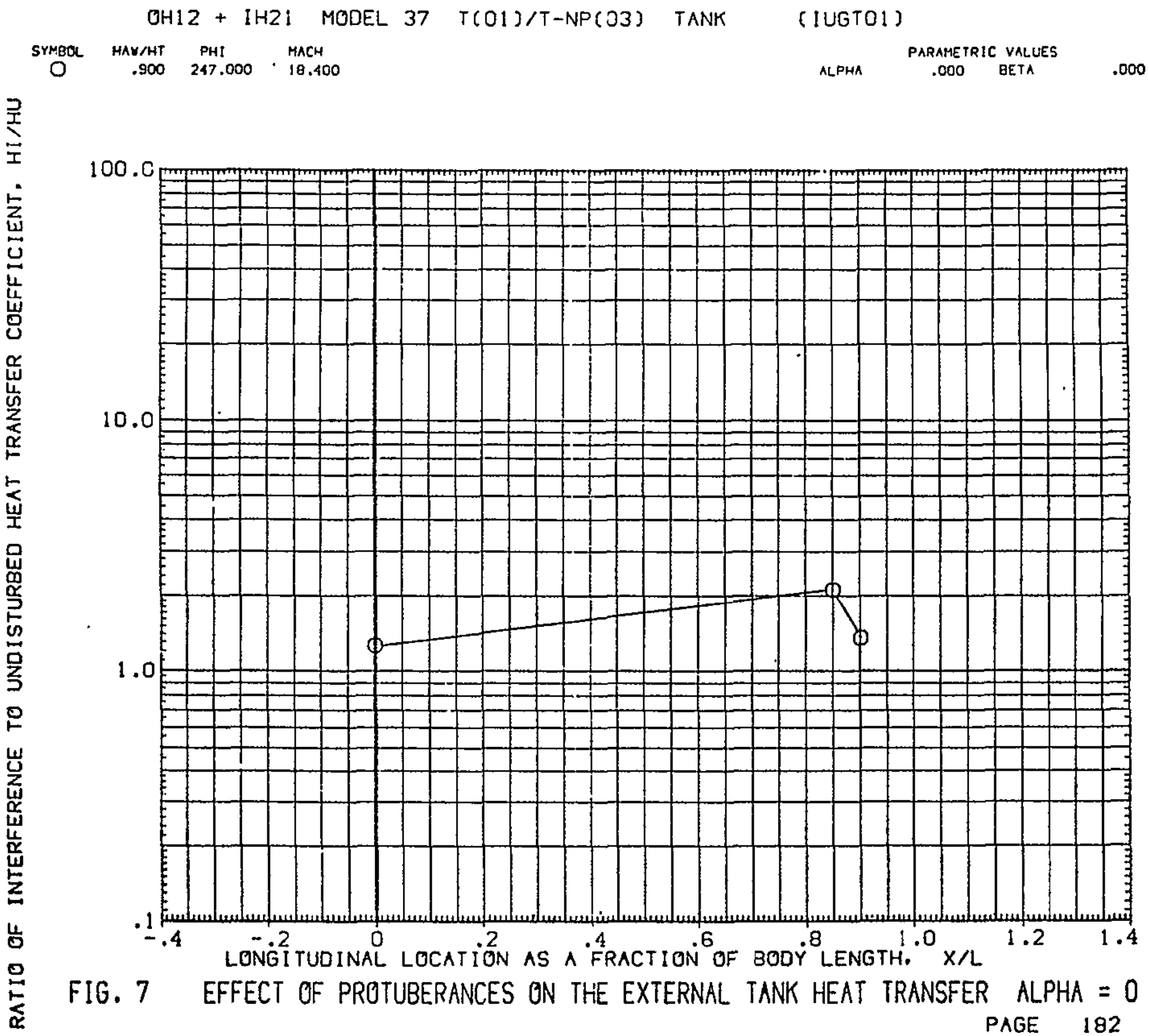

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 T(01)/T-NP(03) TANK (IUGT01)

SYMBOL	HAW/HI	PHI	MACH
O	.900	270.000	18.400

PARAMETRIC VALUES

ALPHA .000 BETA .000

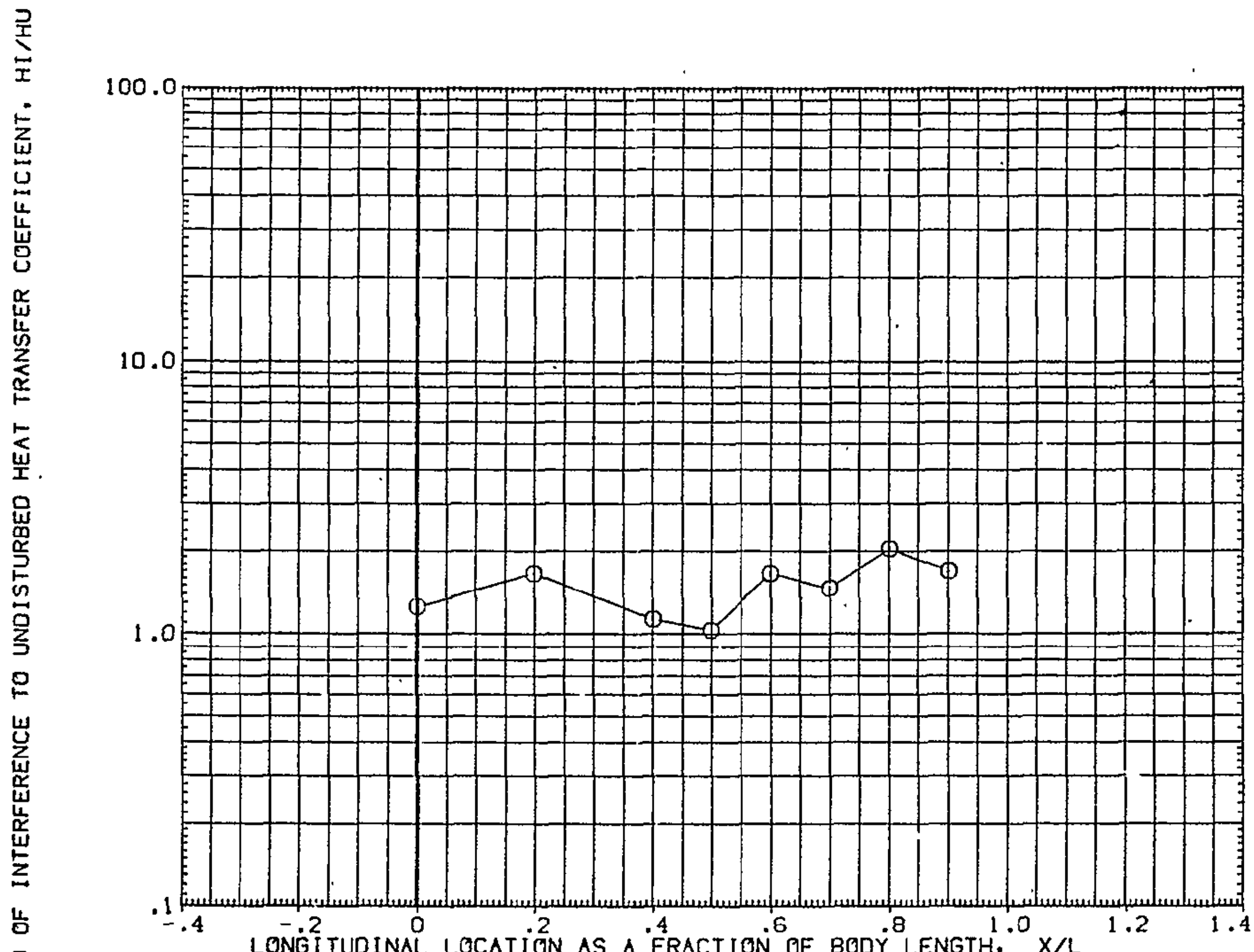

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 T(O1)/T-NP(O3) TANK (IUGT01)

SYMBOL	HAW/HT	PHI	MACH	PARAMETRIC VALUES			
O	.900	315.000	18.400	ALPHA	.000	BETA	.000

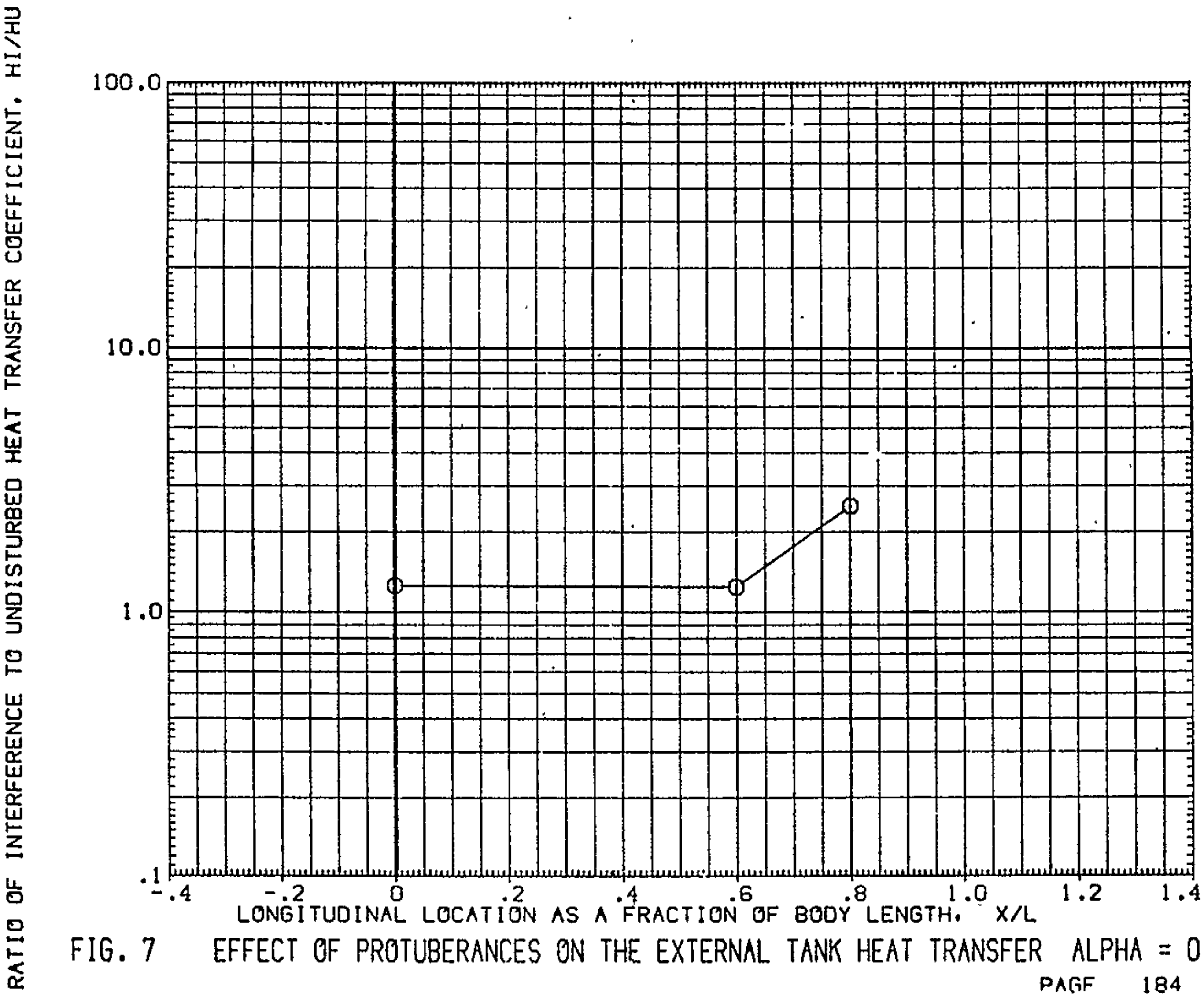

FIG. 7 EFFECT OF PROTUBERANCES ON THE EXTERNAL TANK HEAT TRANSFER ALPHA = 0

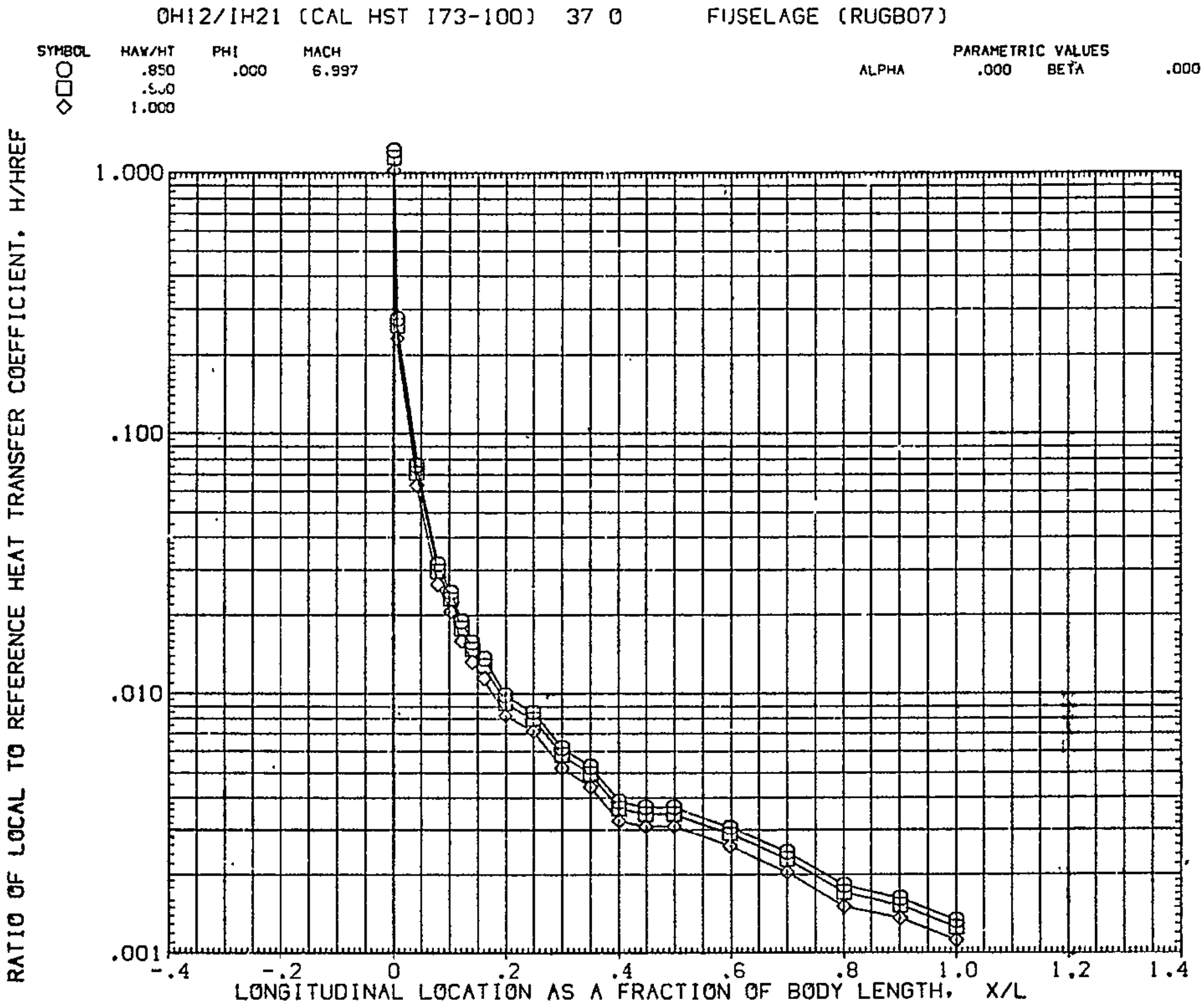

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

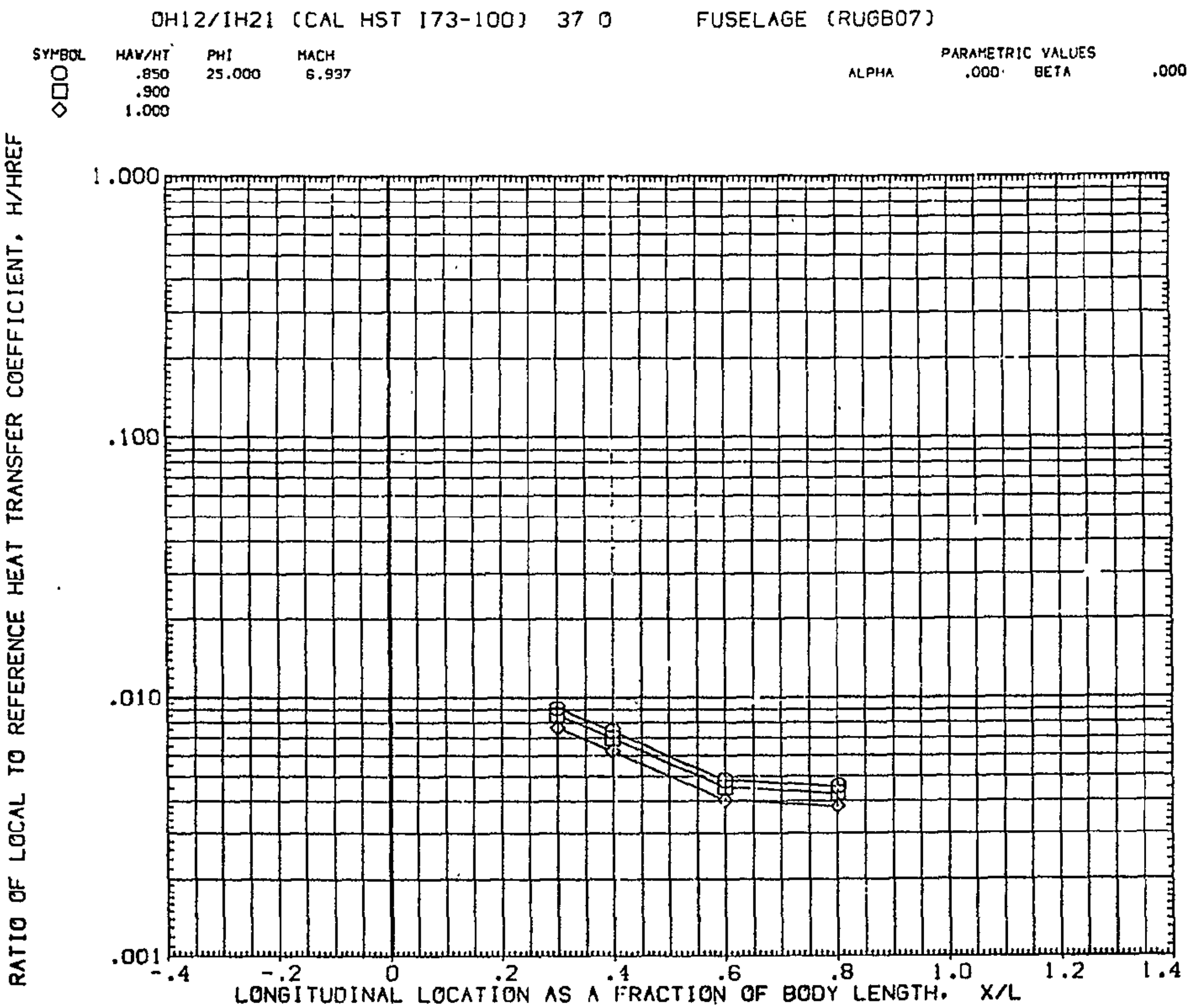

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB07)

SYMBOL	HAV/HT	PHI	MACH
○	.850	30.000	6.997
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

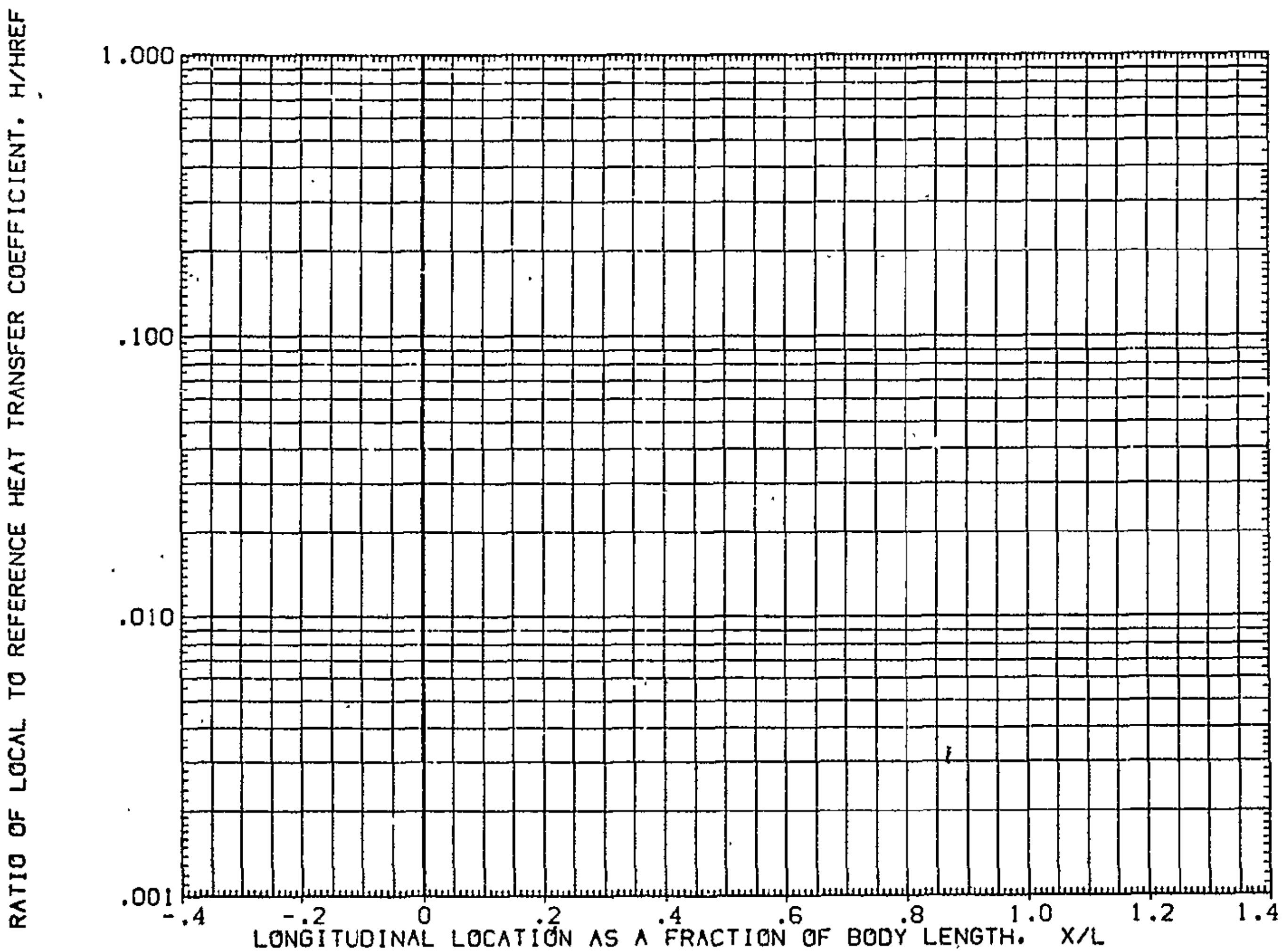

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB07)

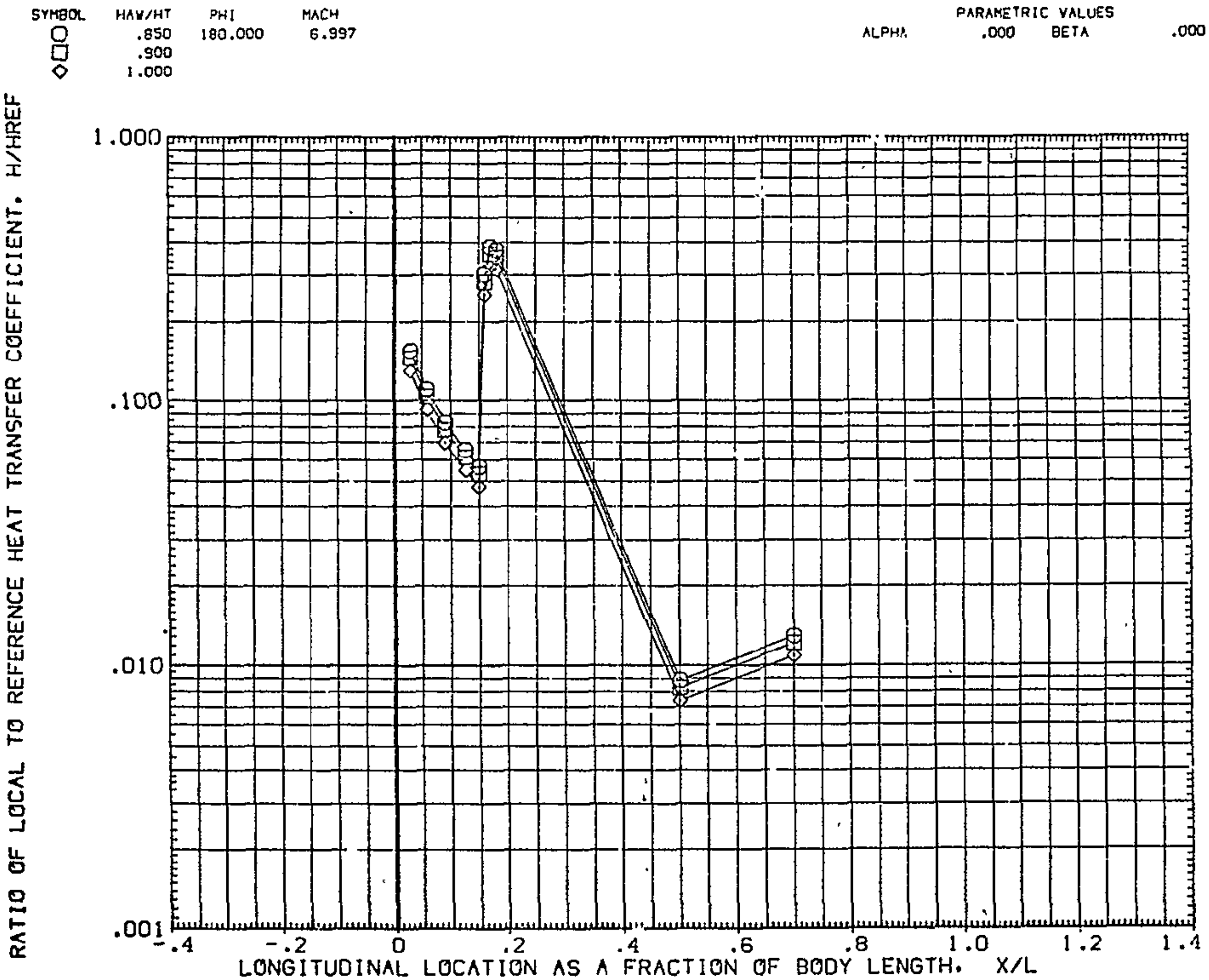

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

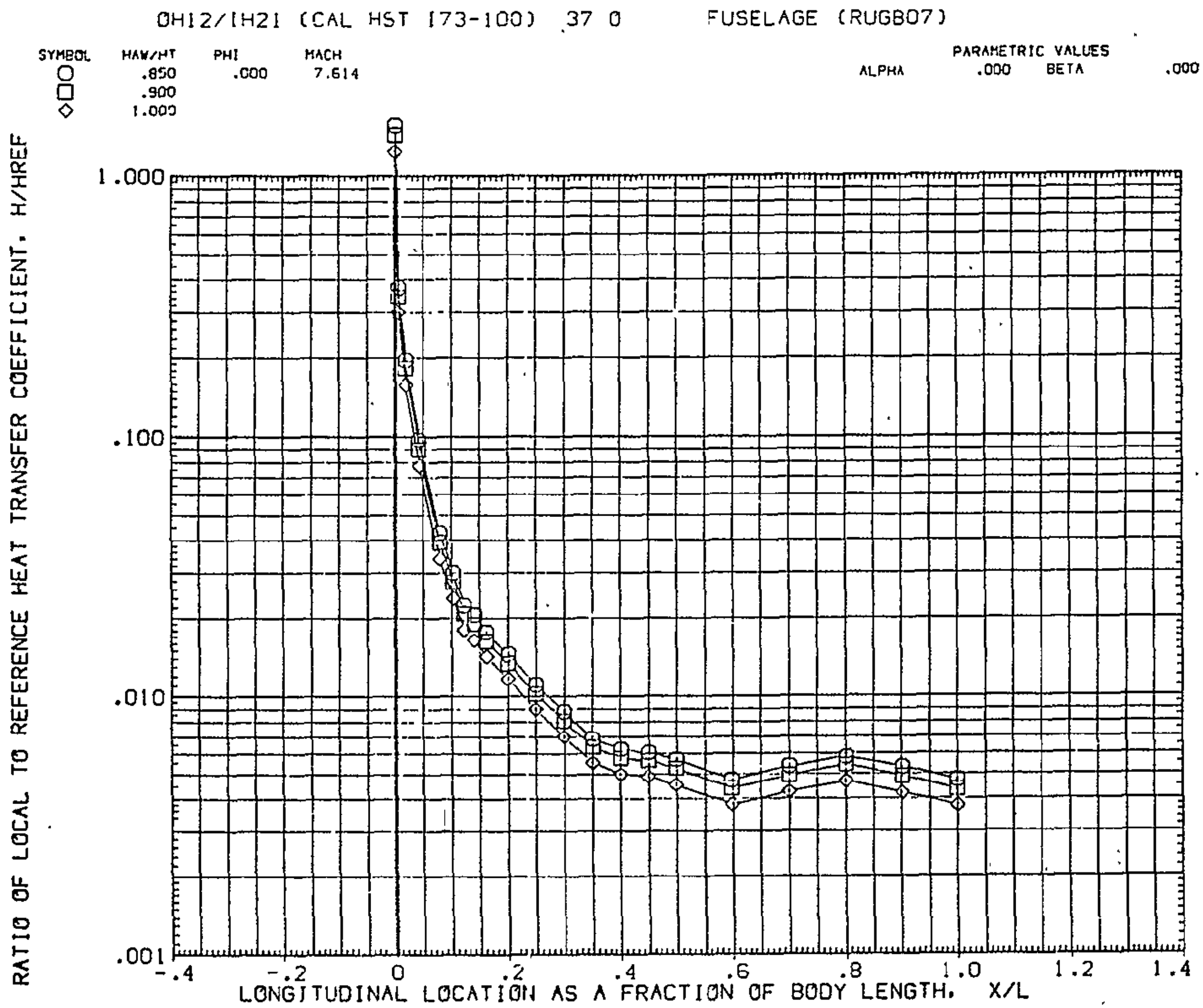

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 FUSELAGE (RUGB07)

SYMBOL	HAW/HT	PHI	MACH
○	.850	25.000	7.614
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

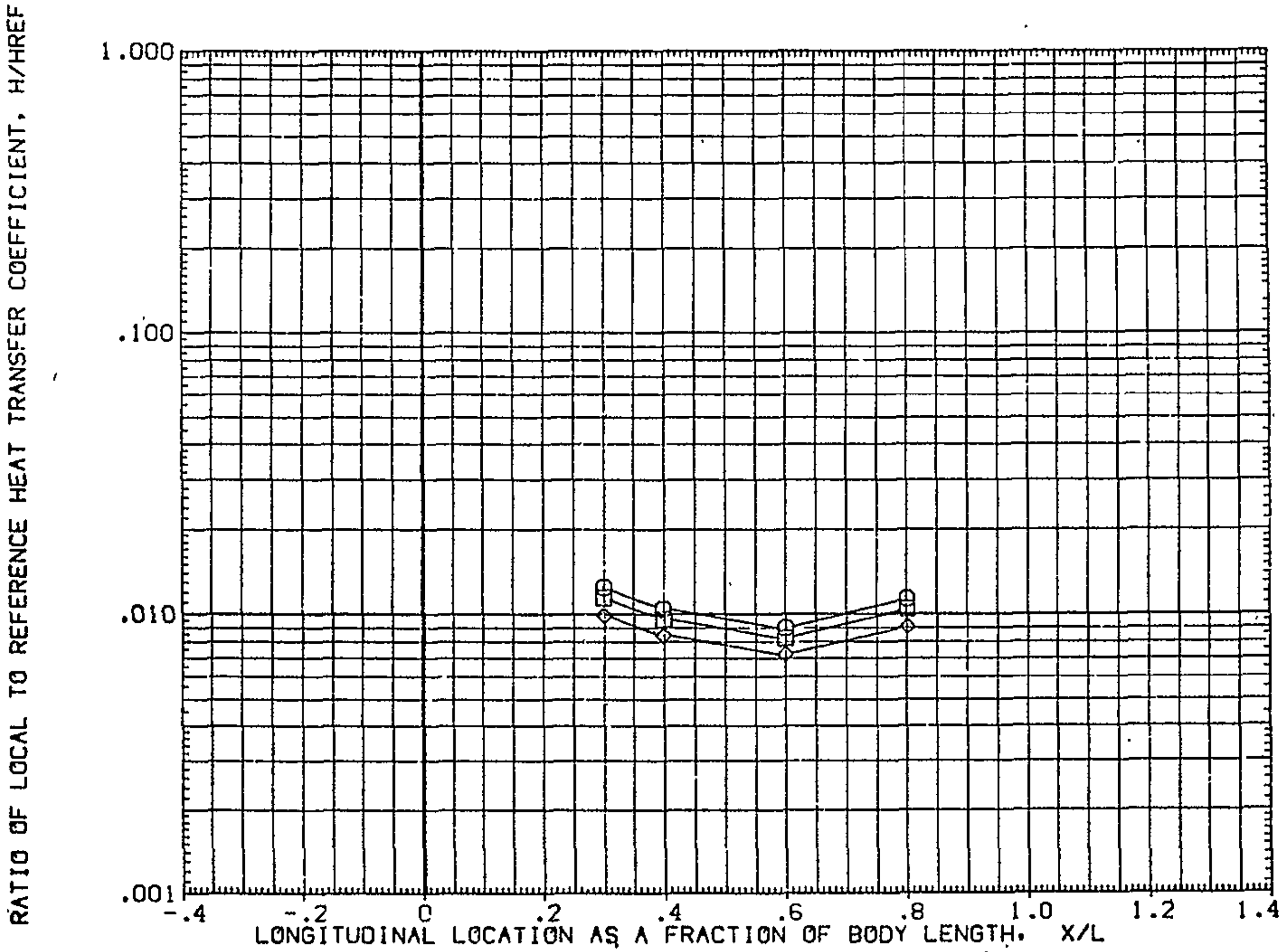

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 FUSELAGE (RUGB07)

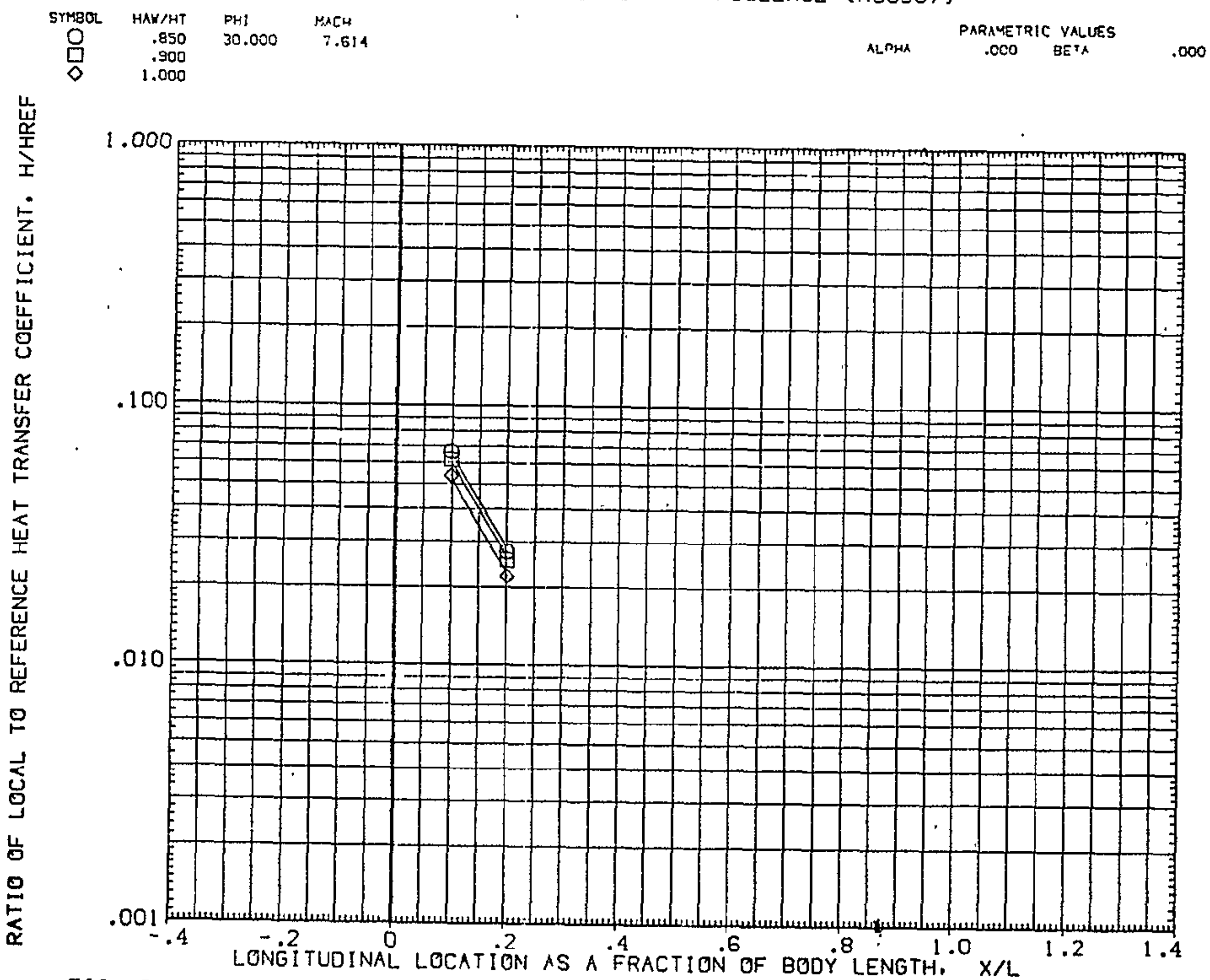

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB07)

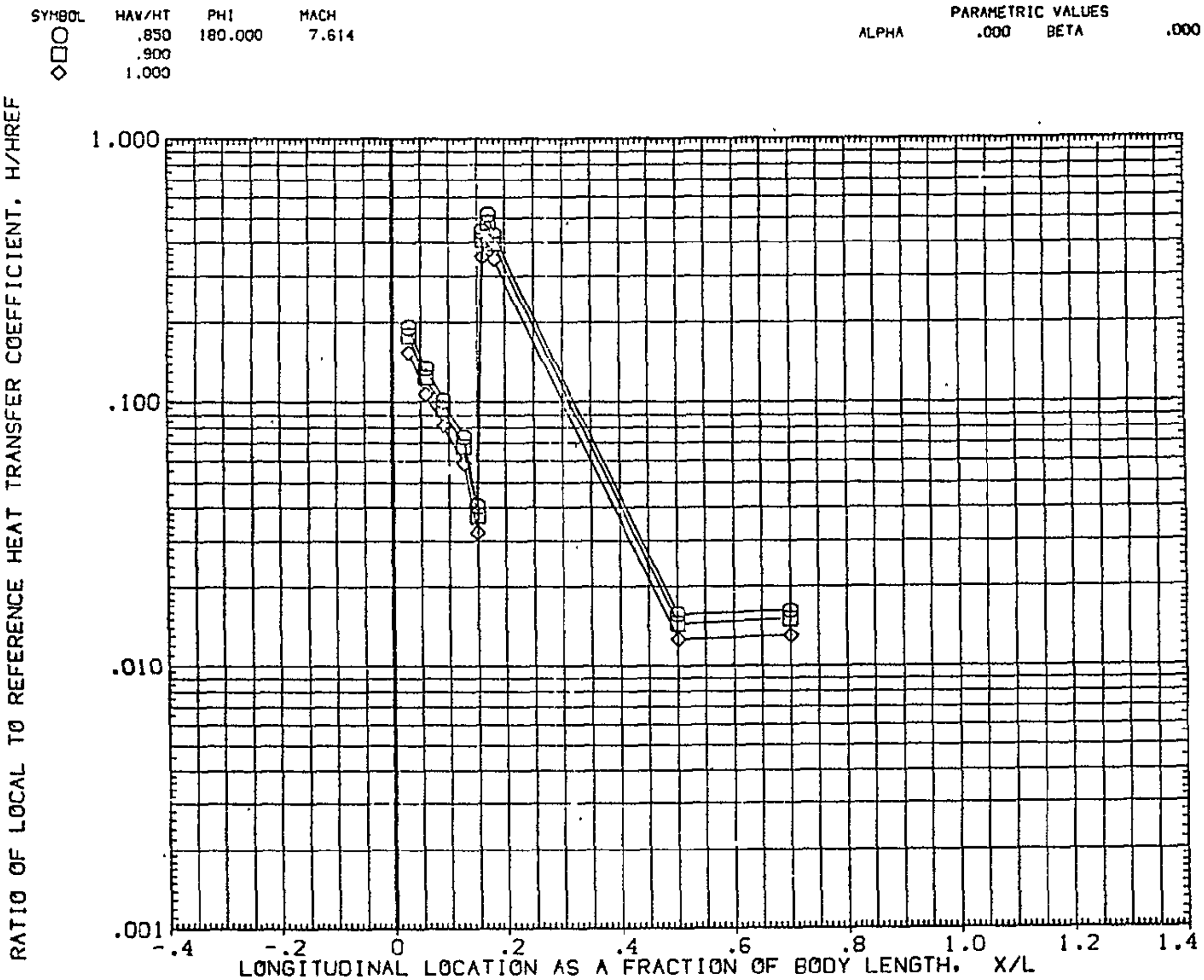

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

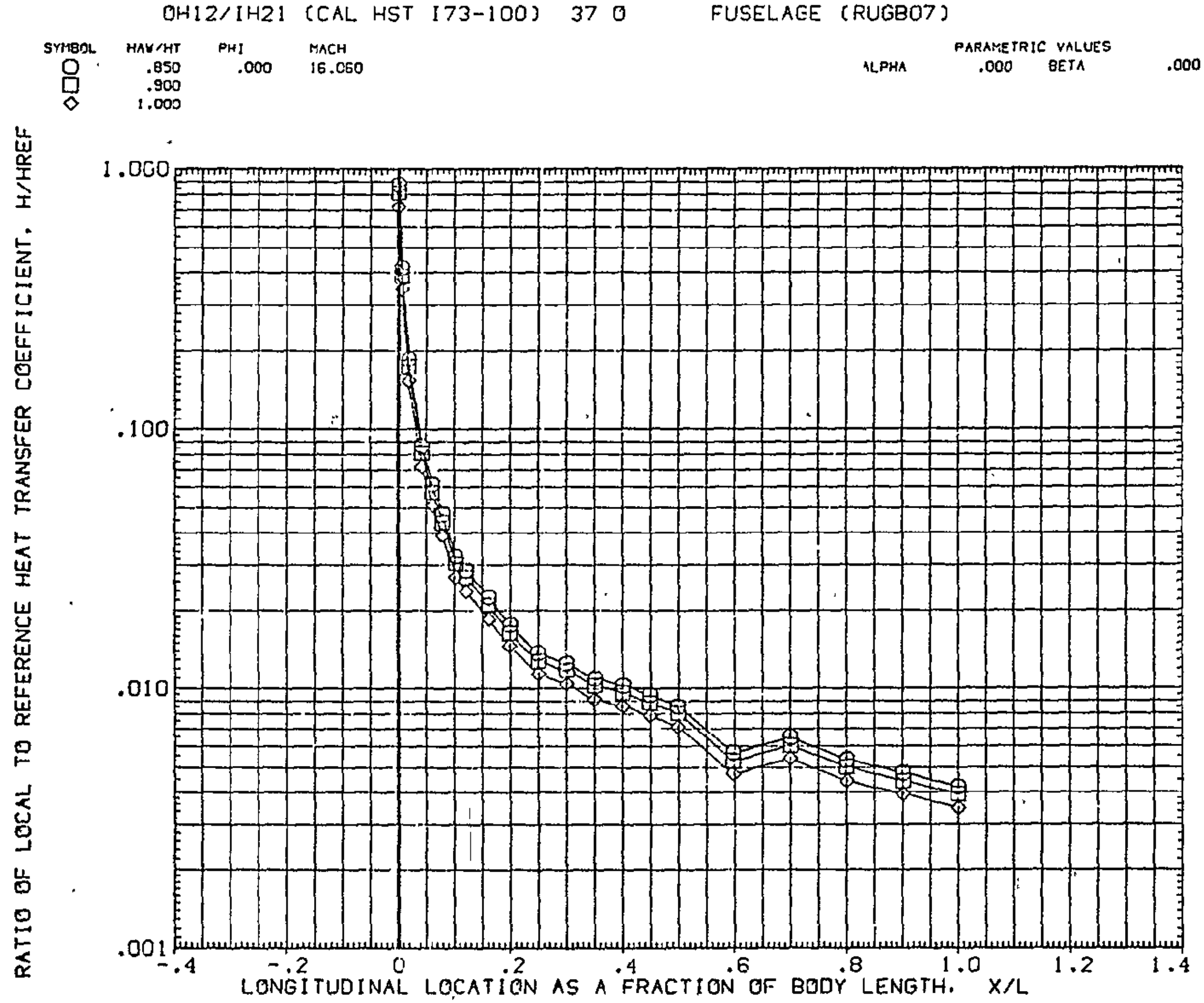

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

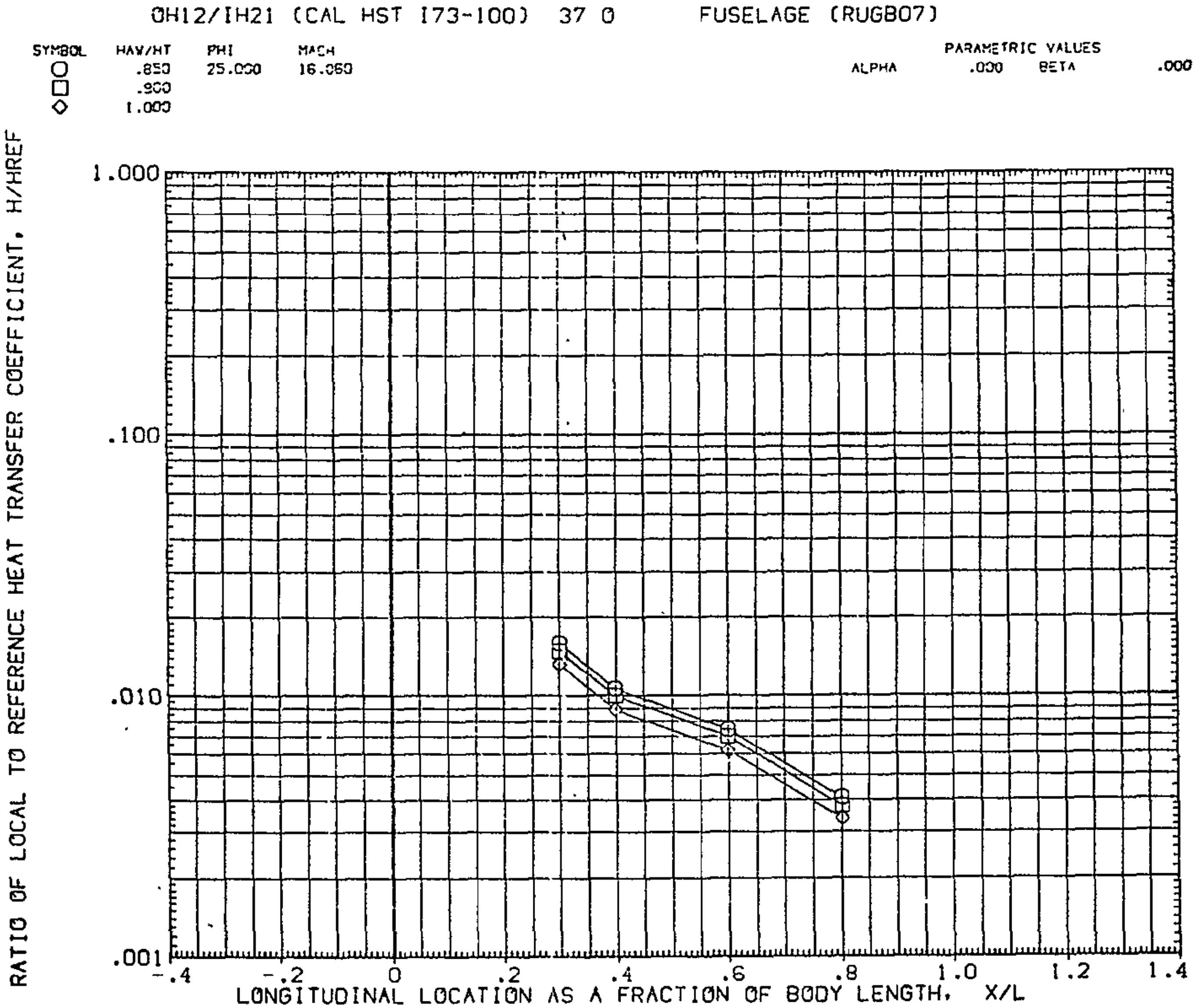

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

QH12/IH21 (CAL HST I73-100) 37 0 FUSEL\GE (RUGB07)

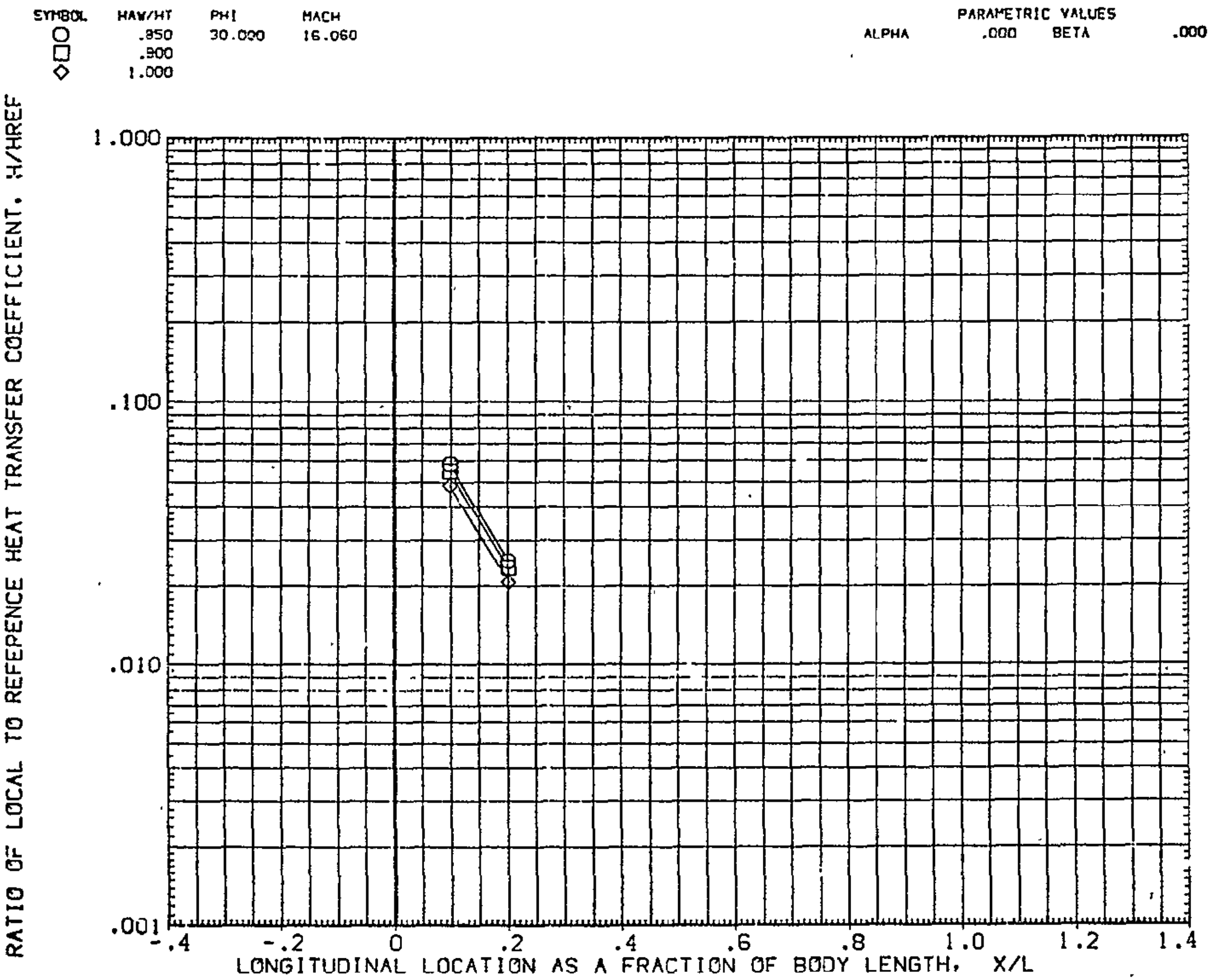

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

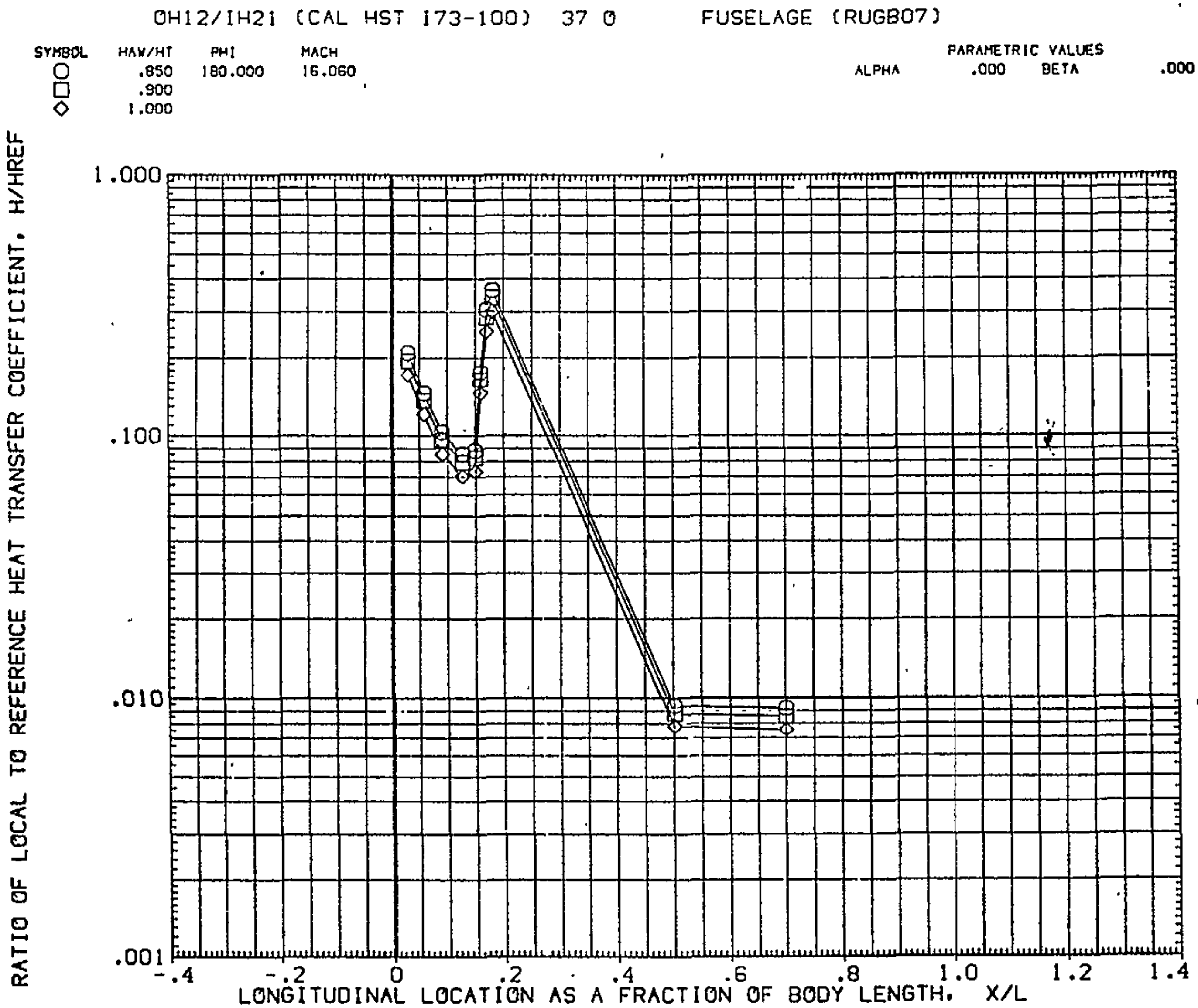

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

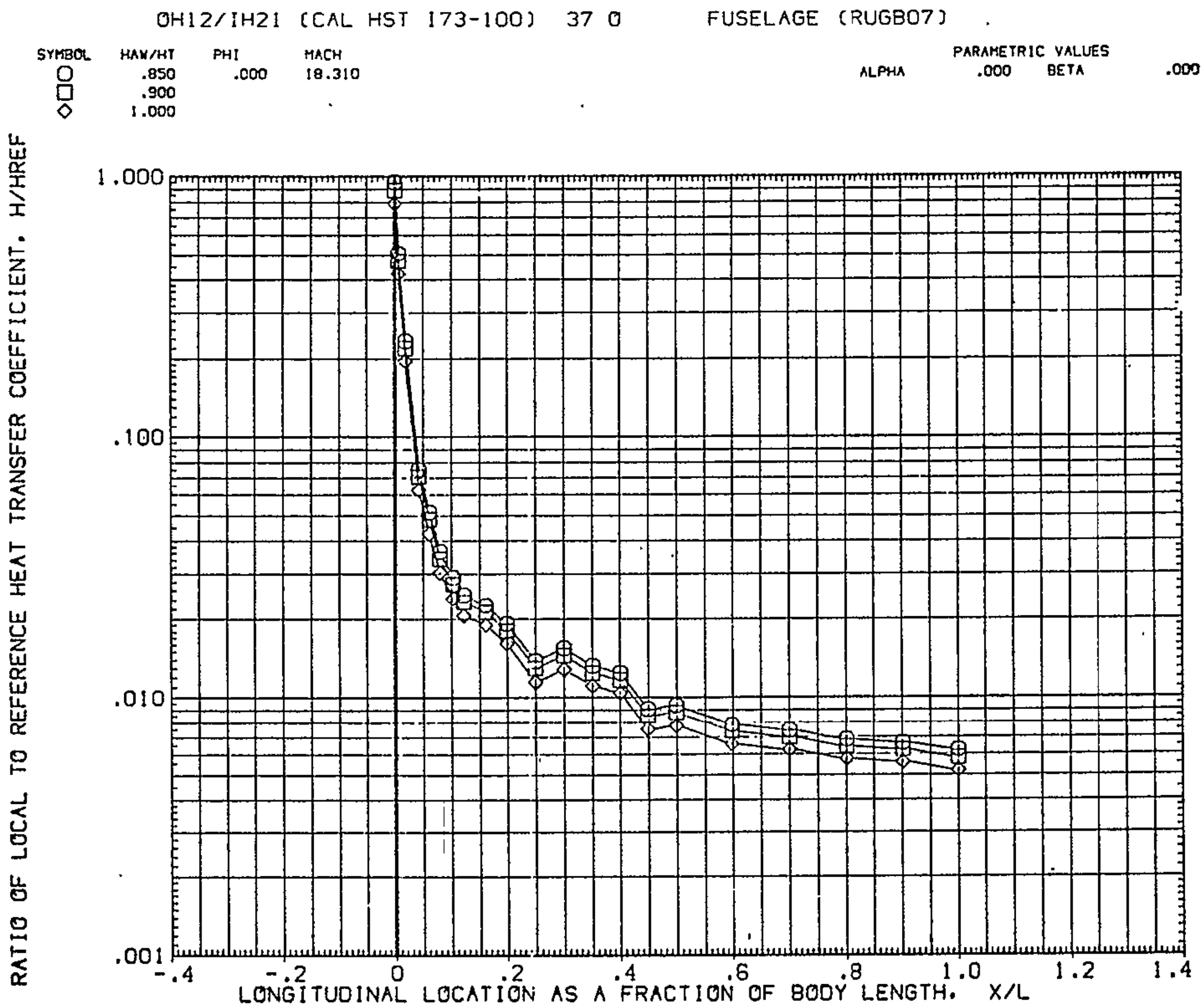

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

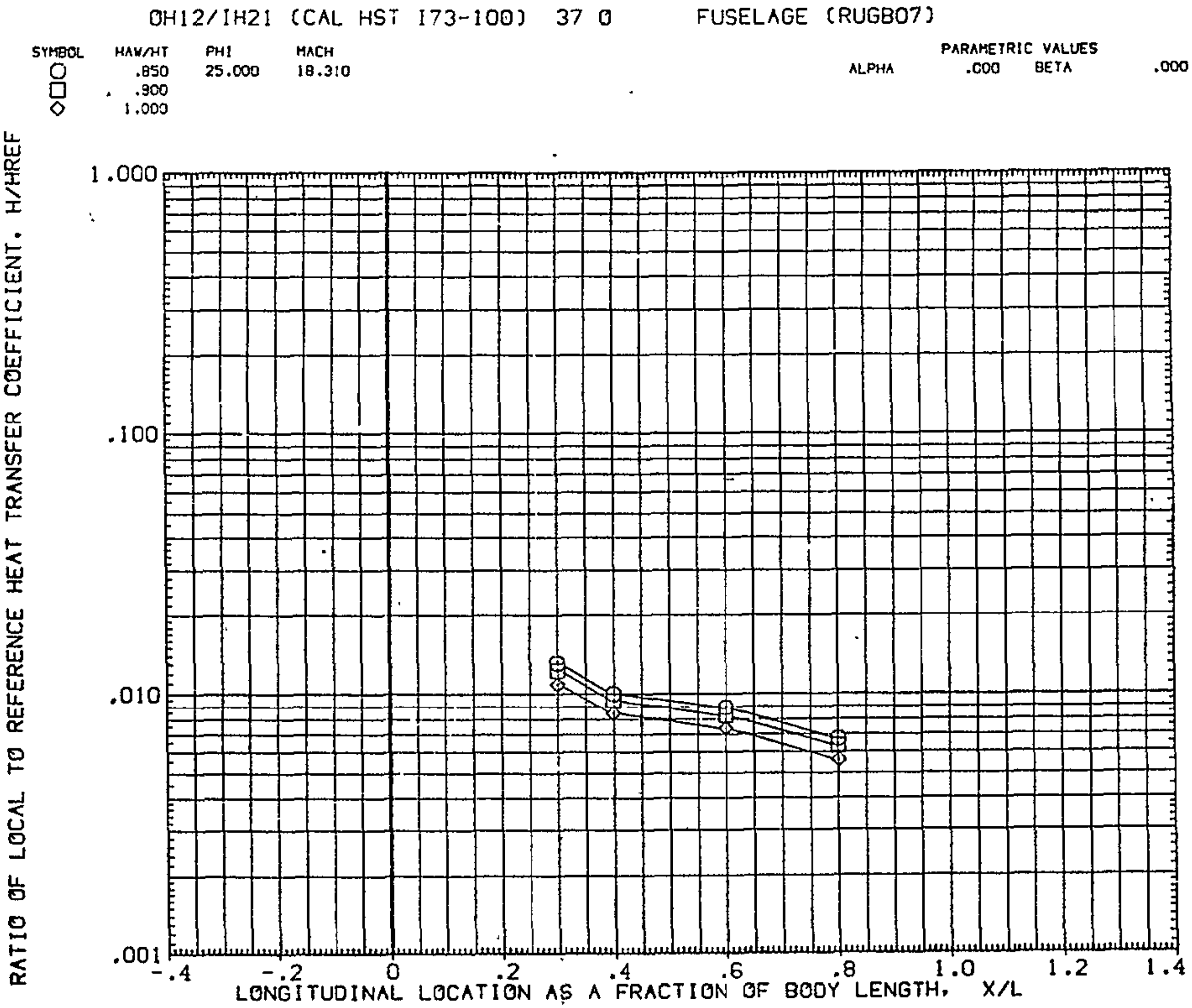

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

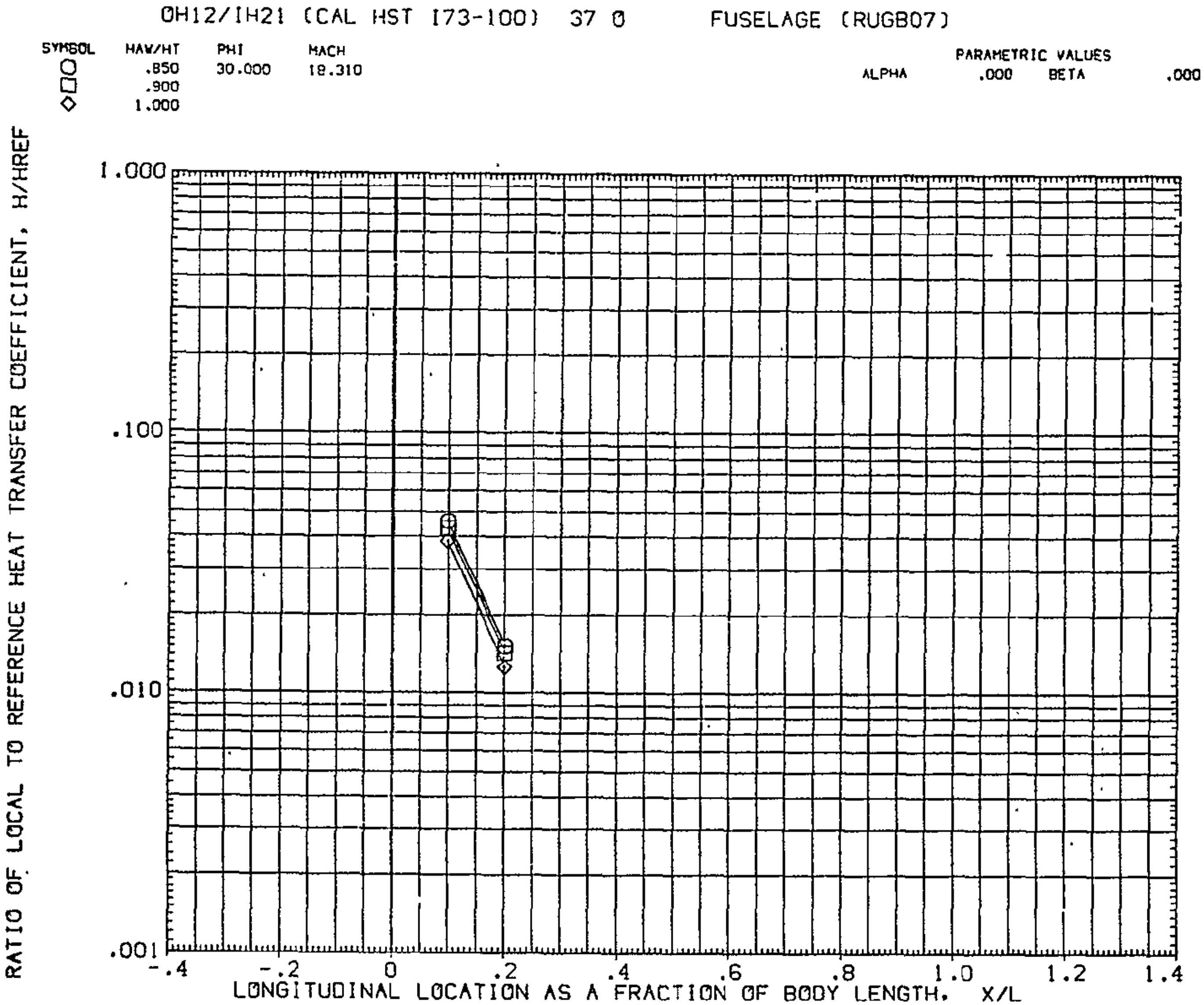

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

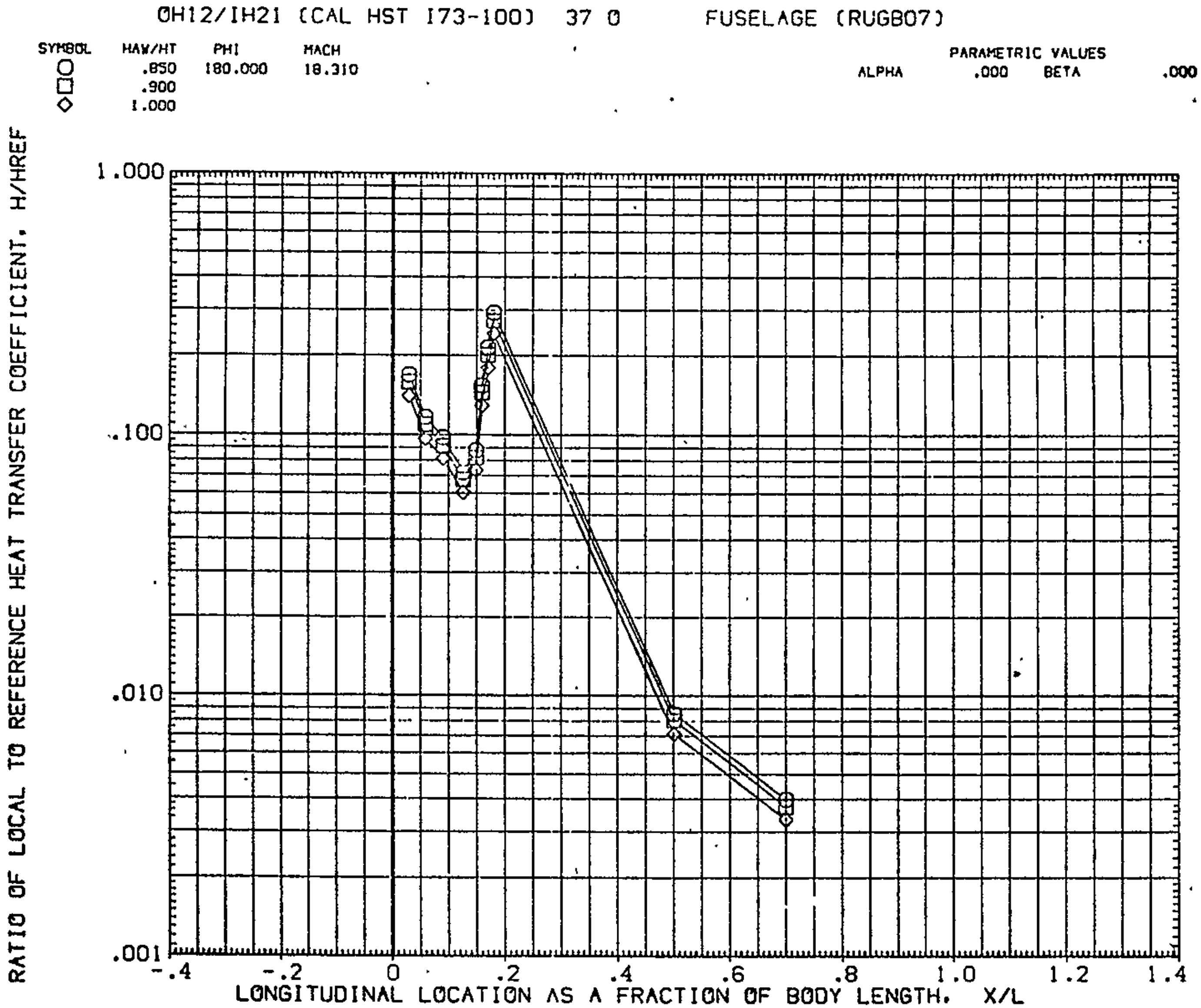

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

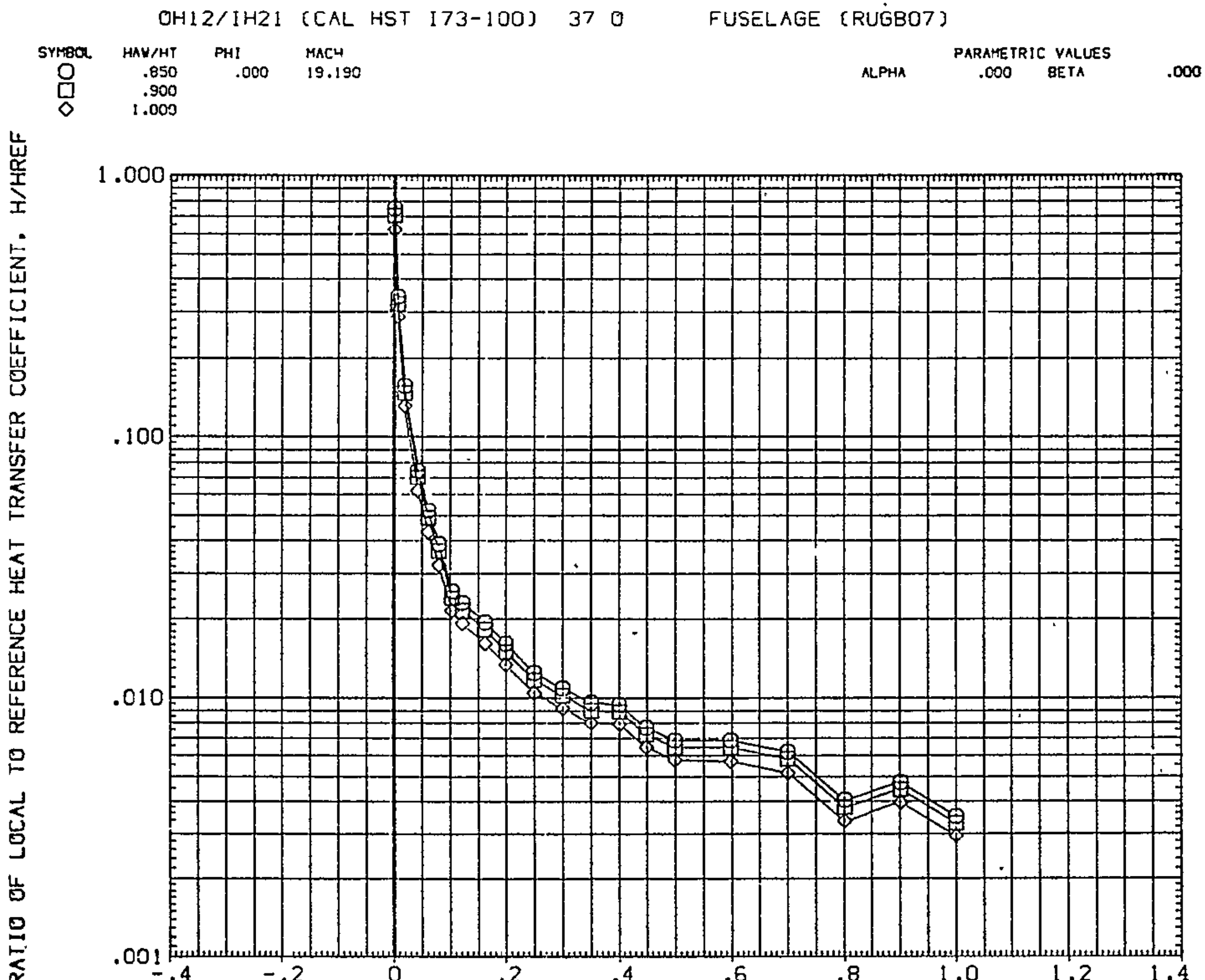

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

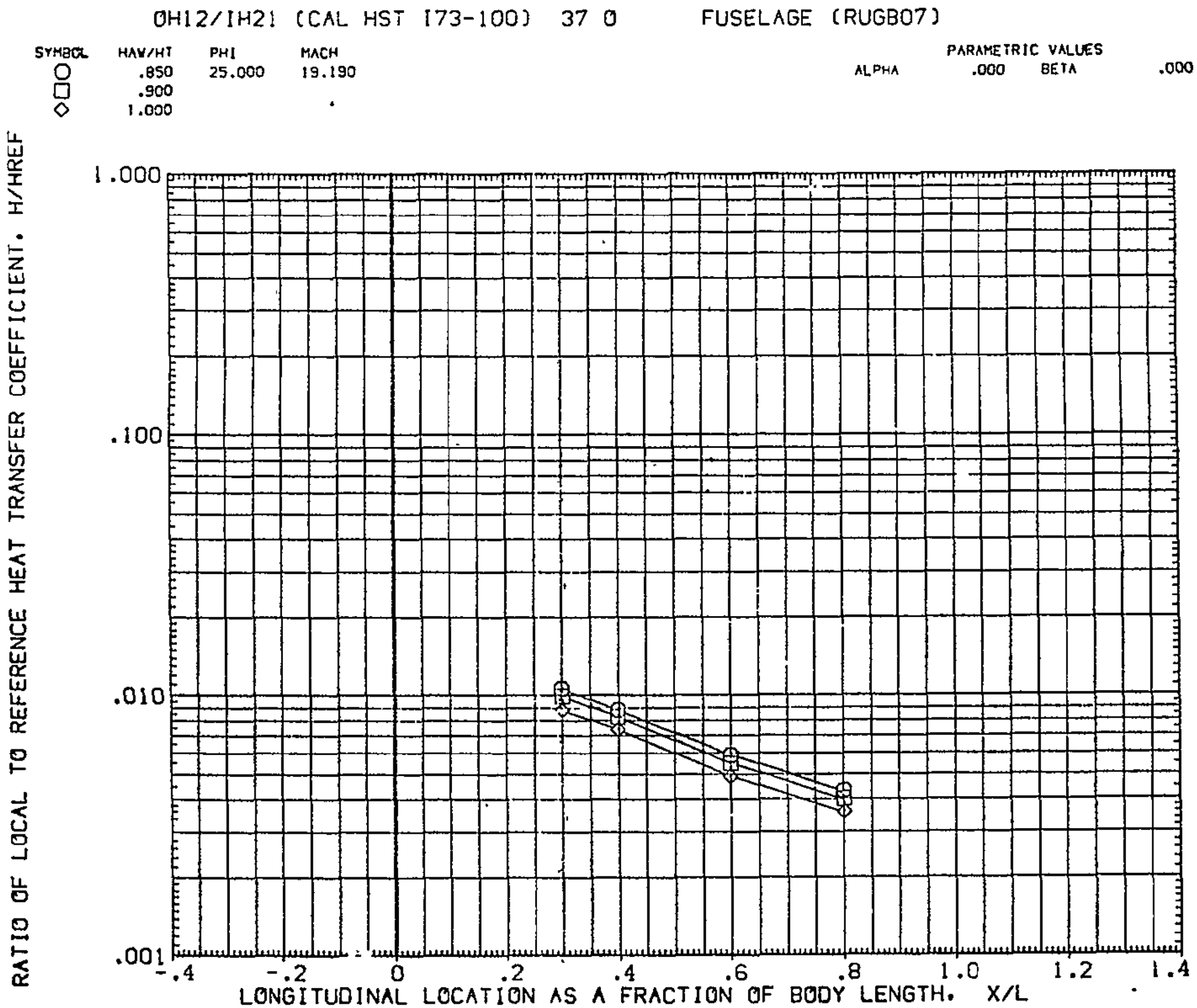

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB07)

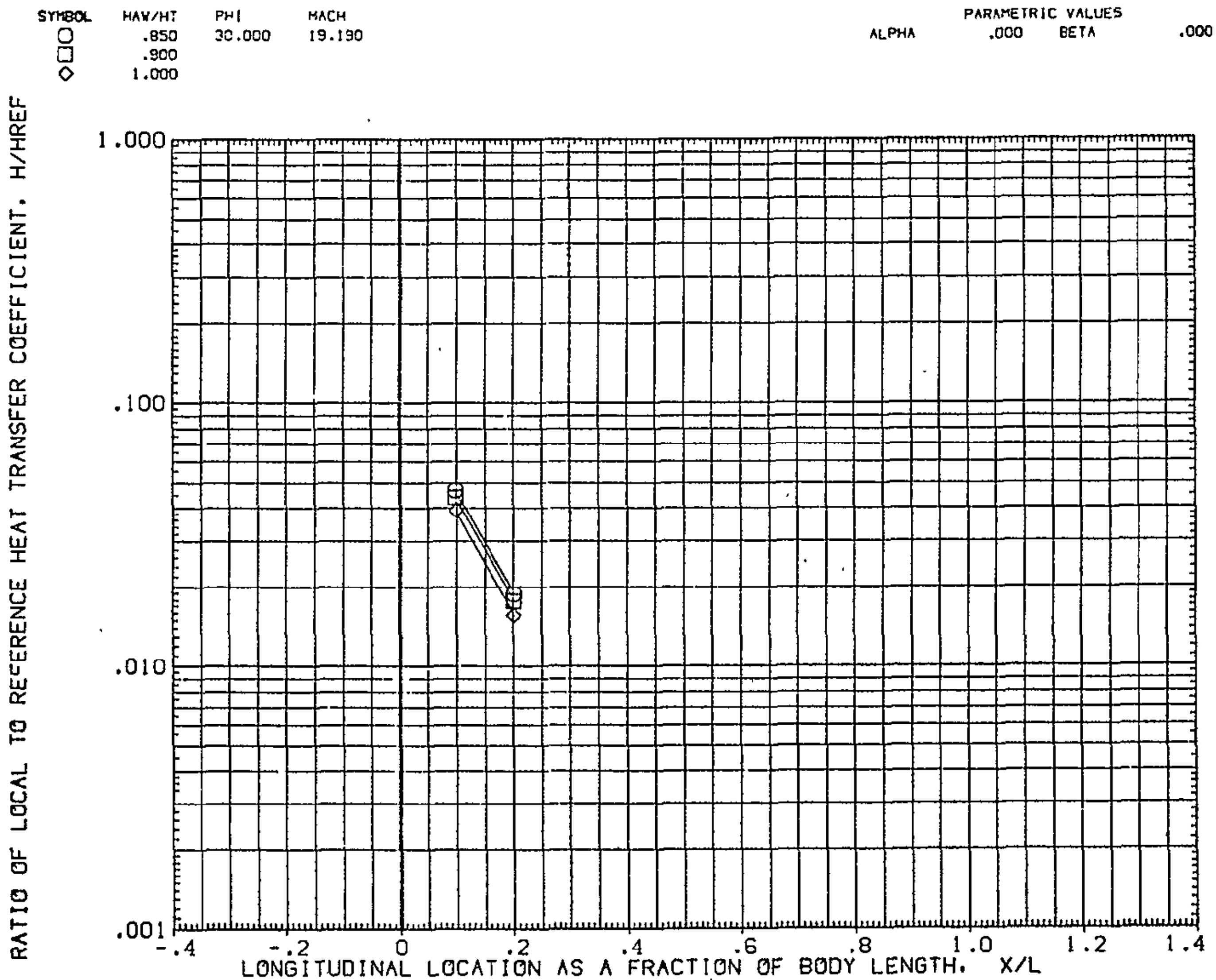

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

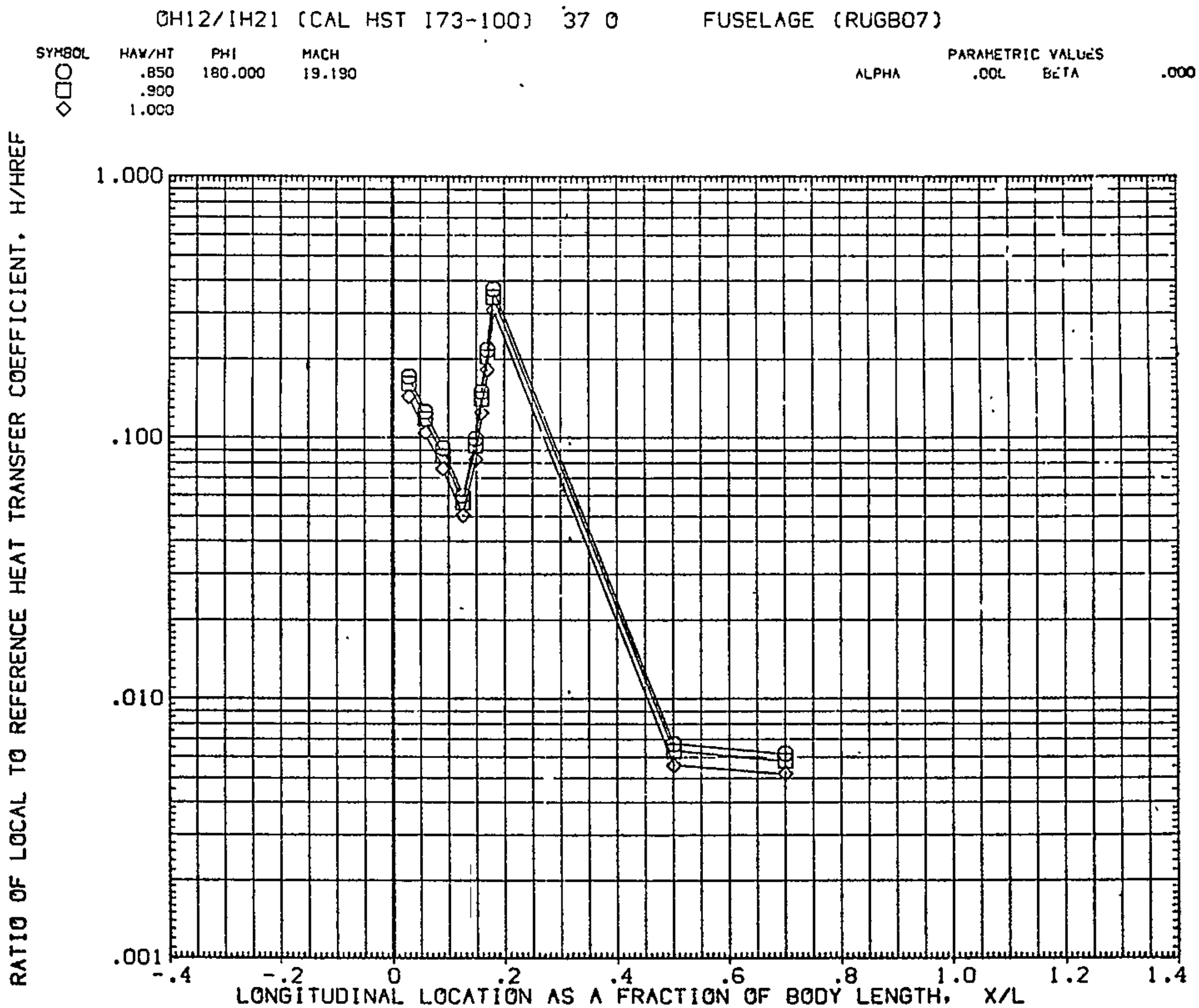

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

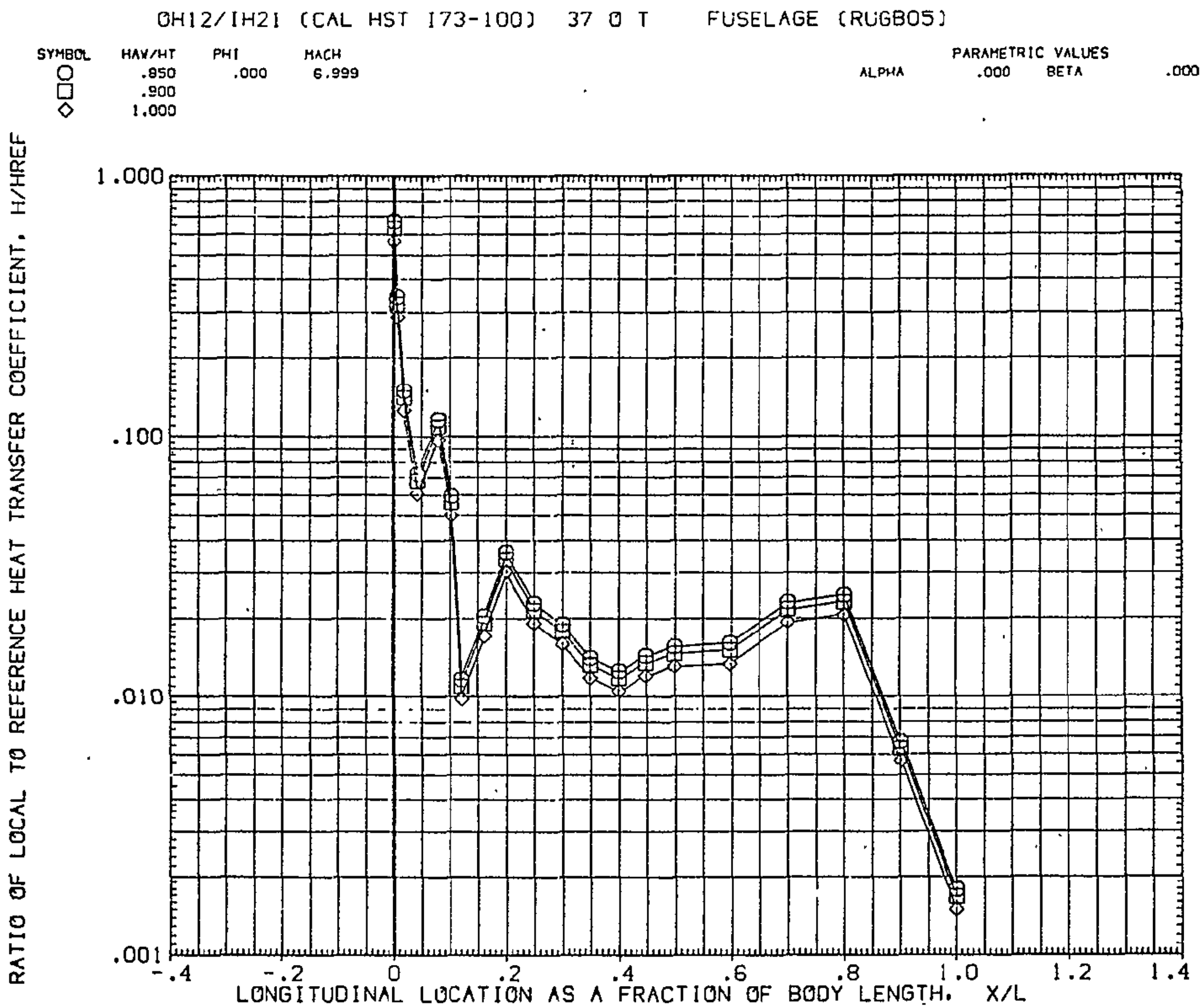

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

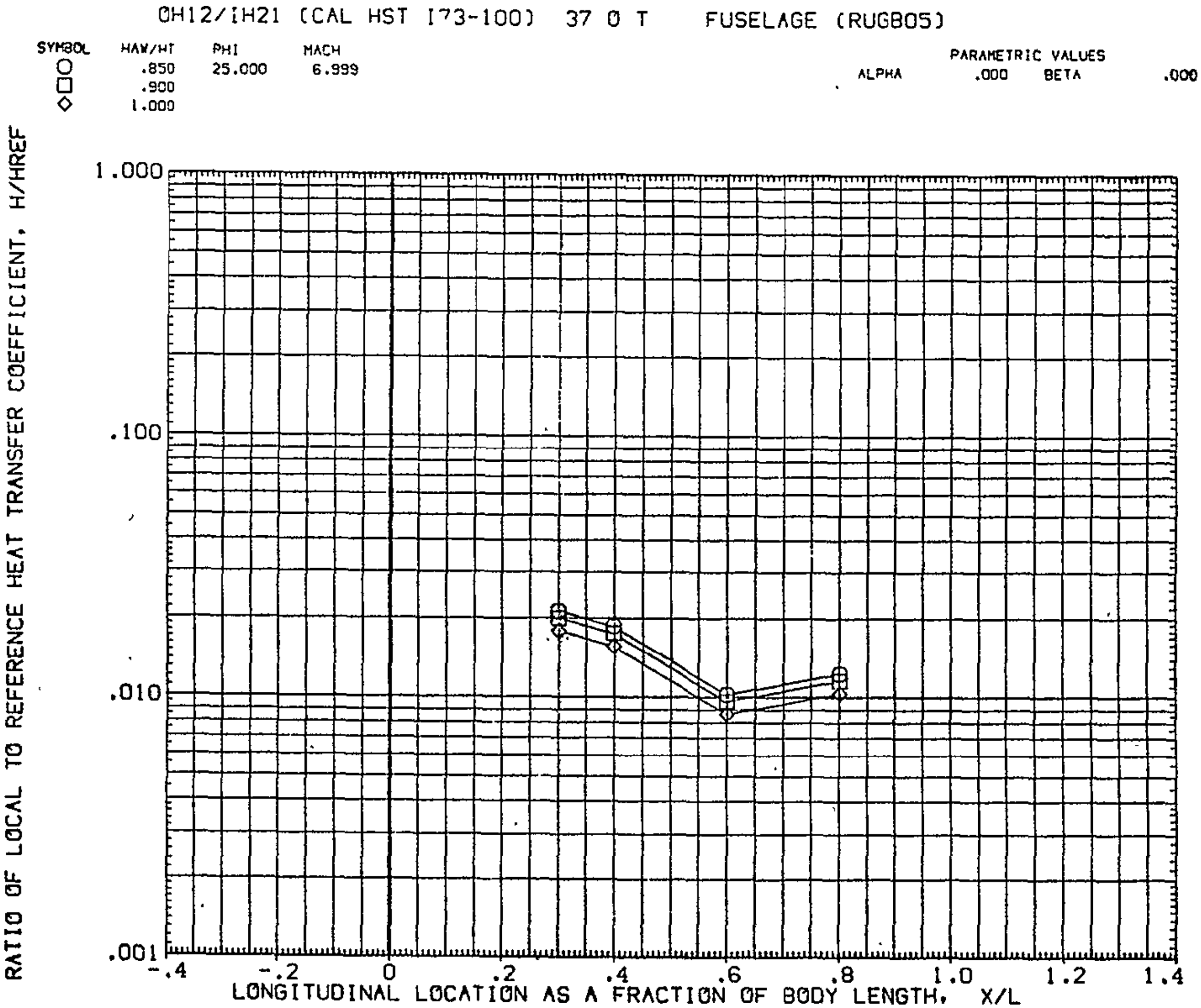

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

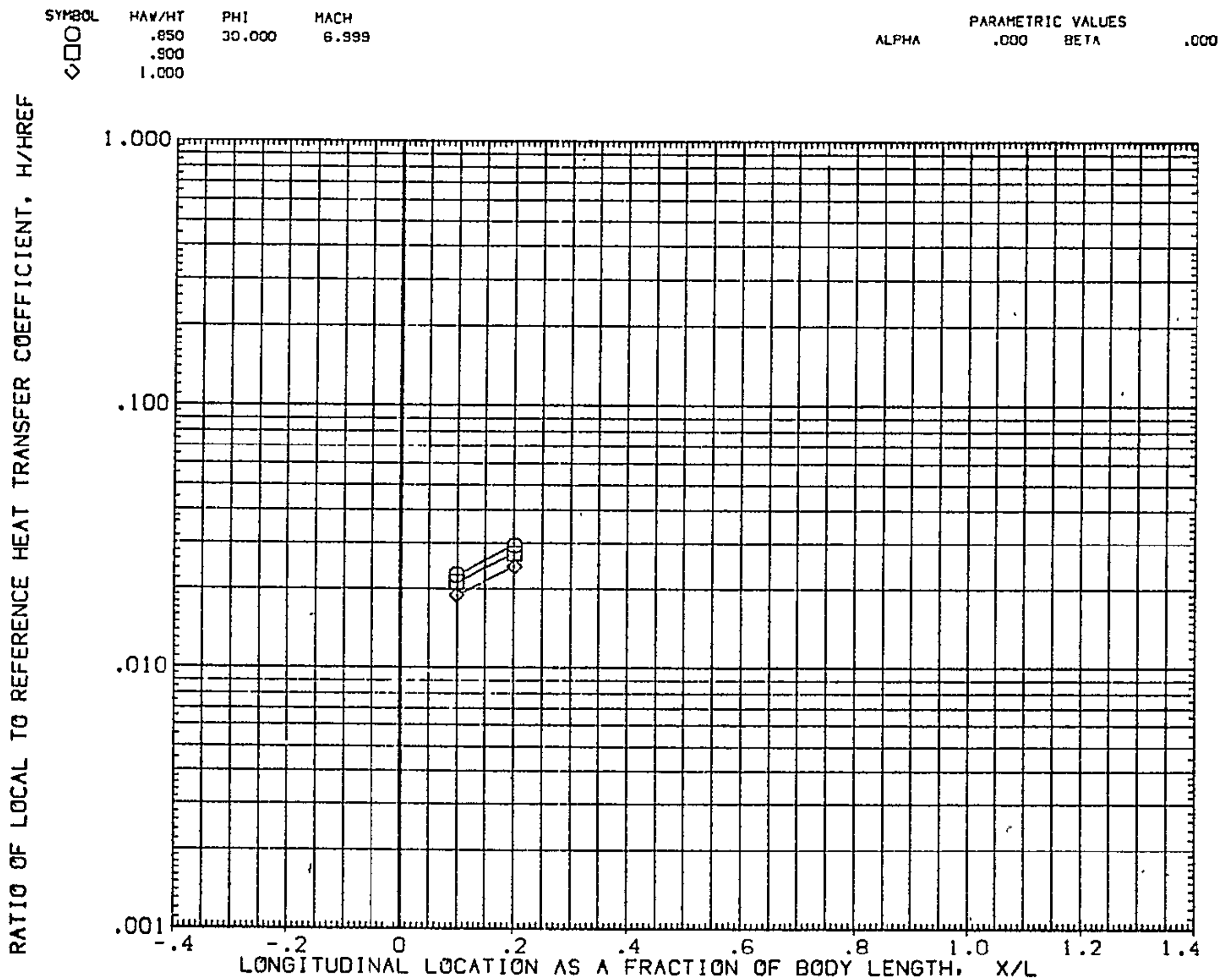

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

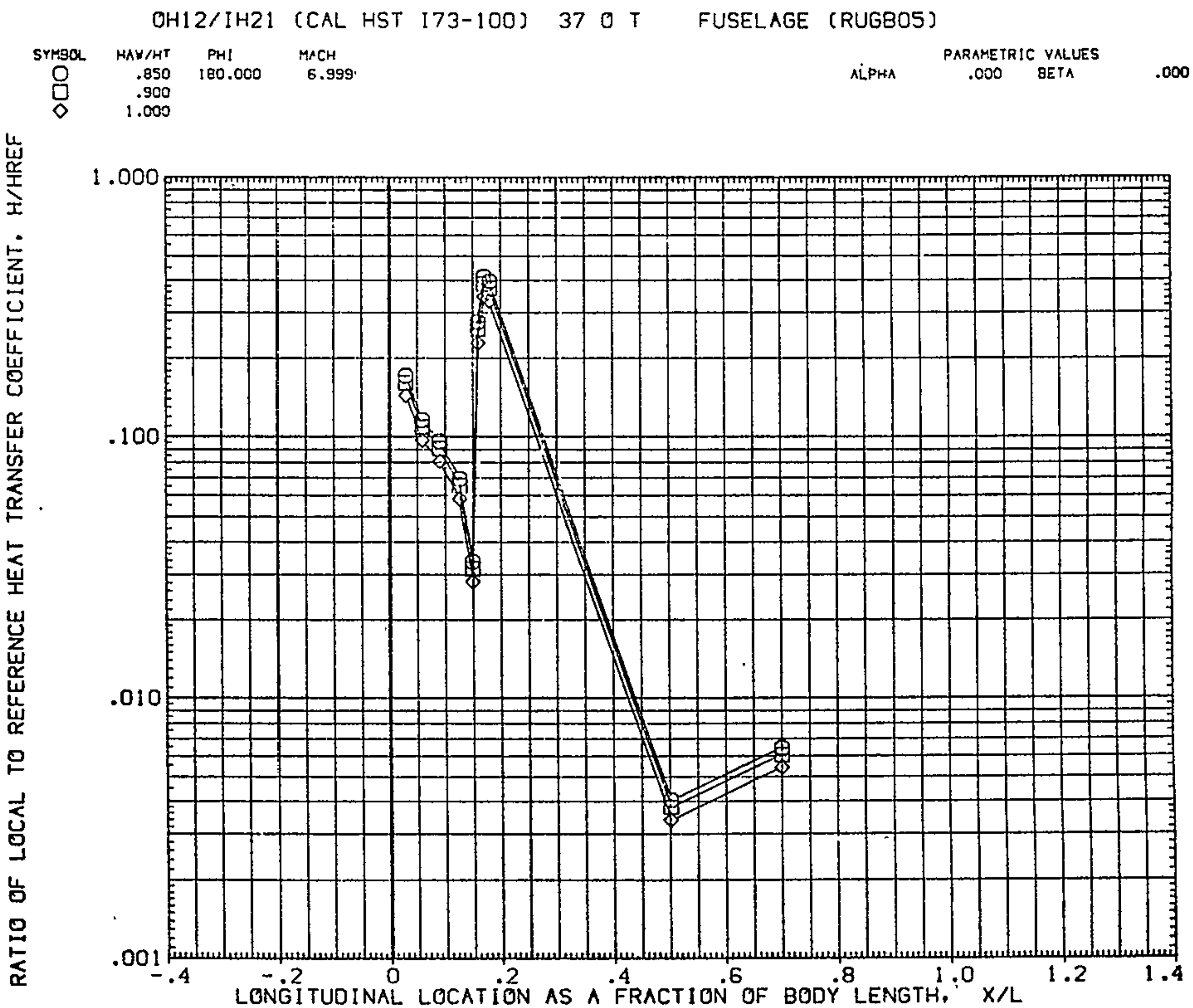

FIG. 8- EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

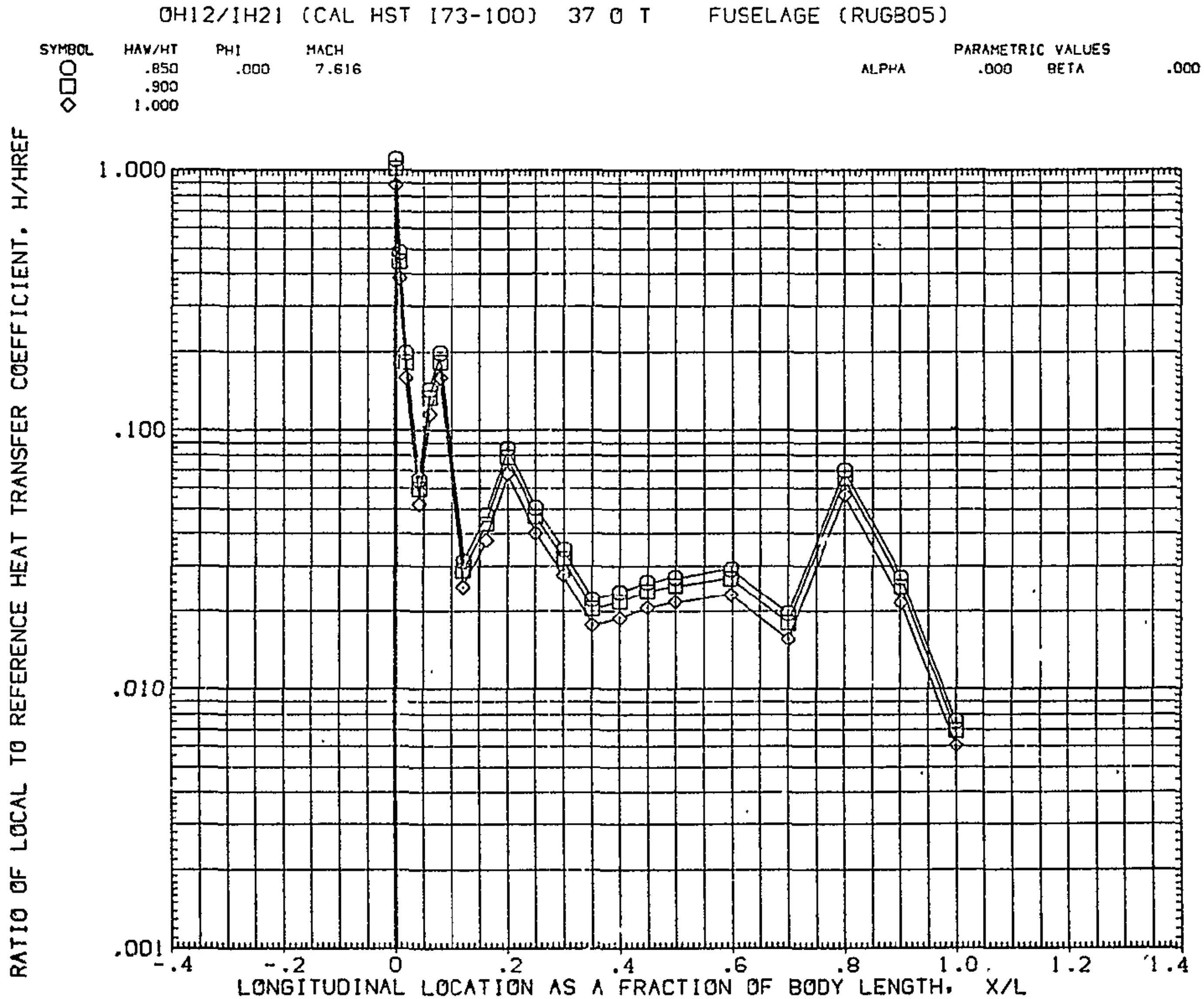

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T FUSELAGE (RUGB05)

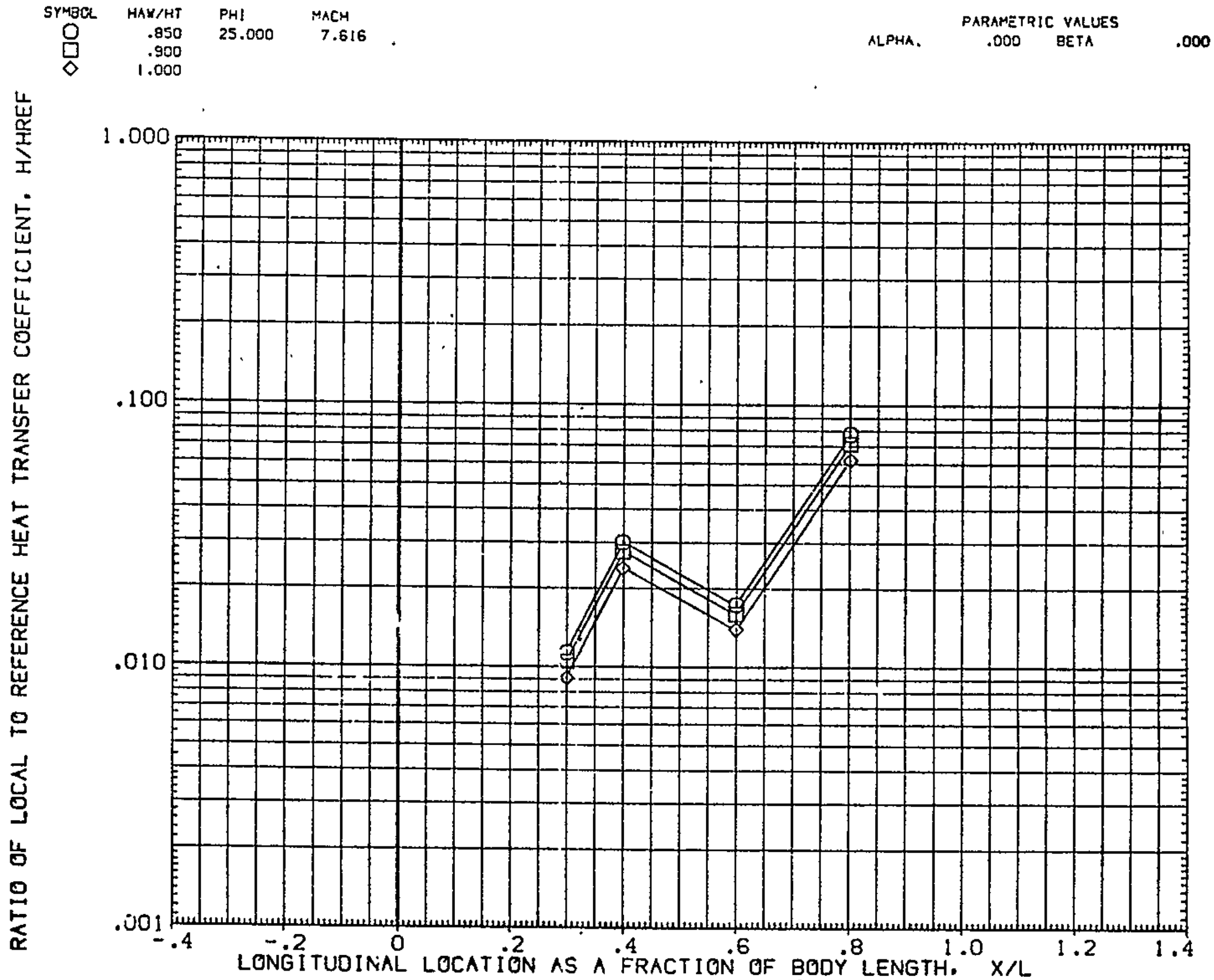

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

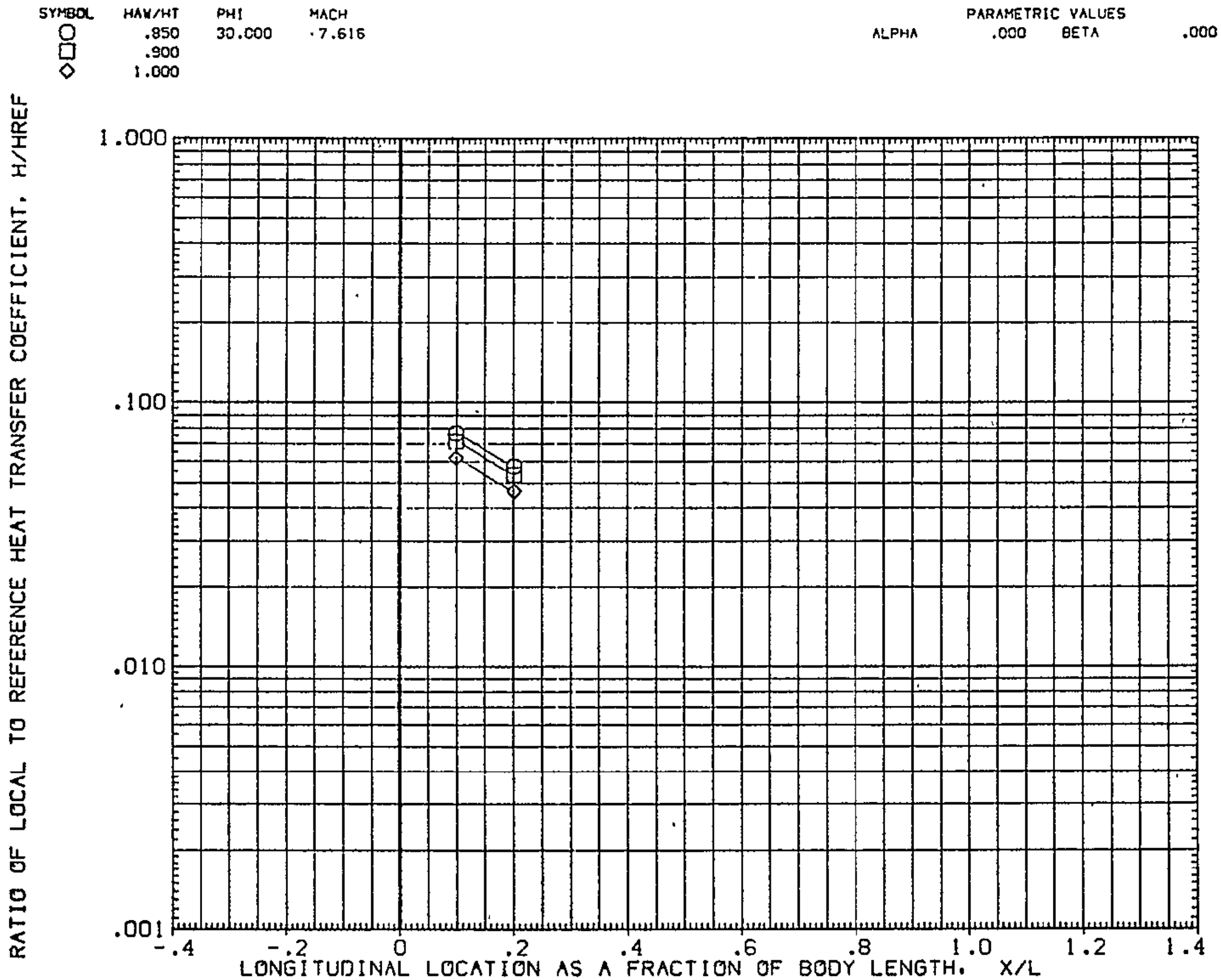

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

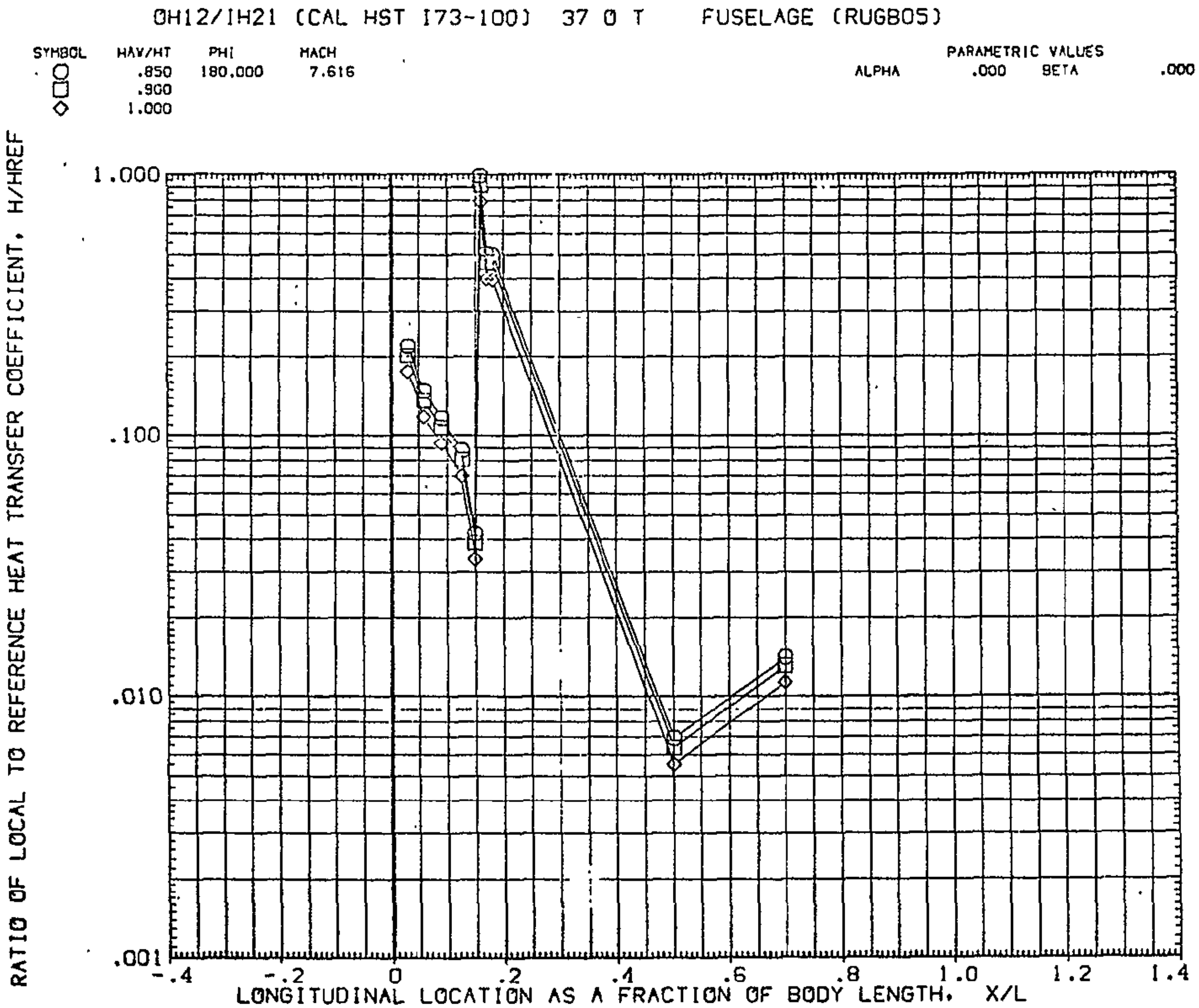

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

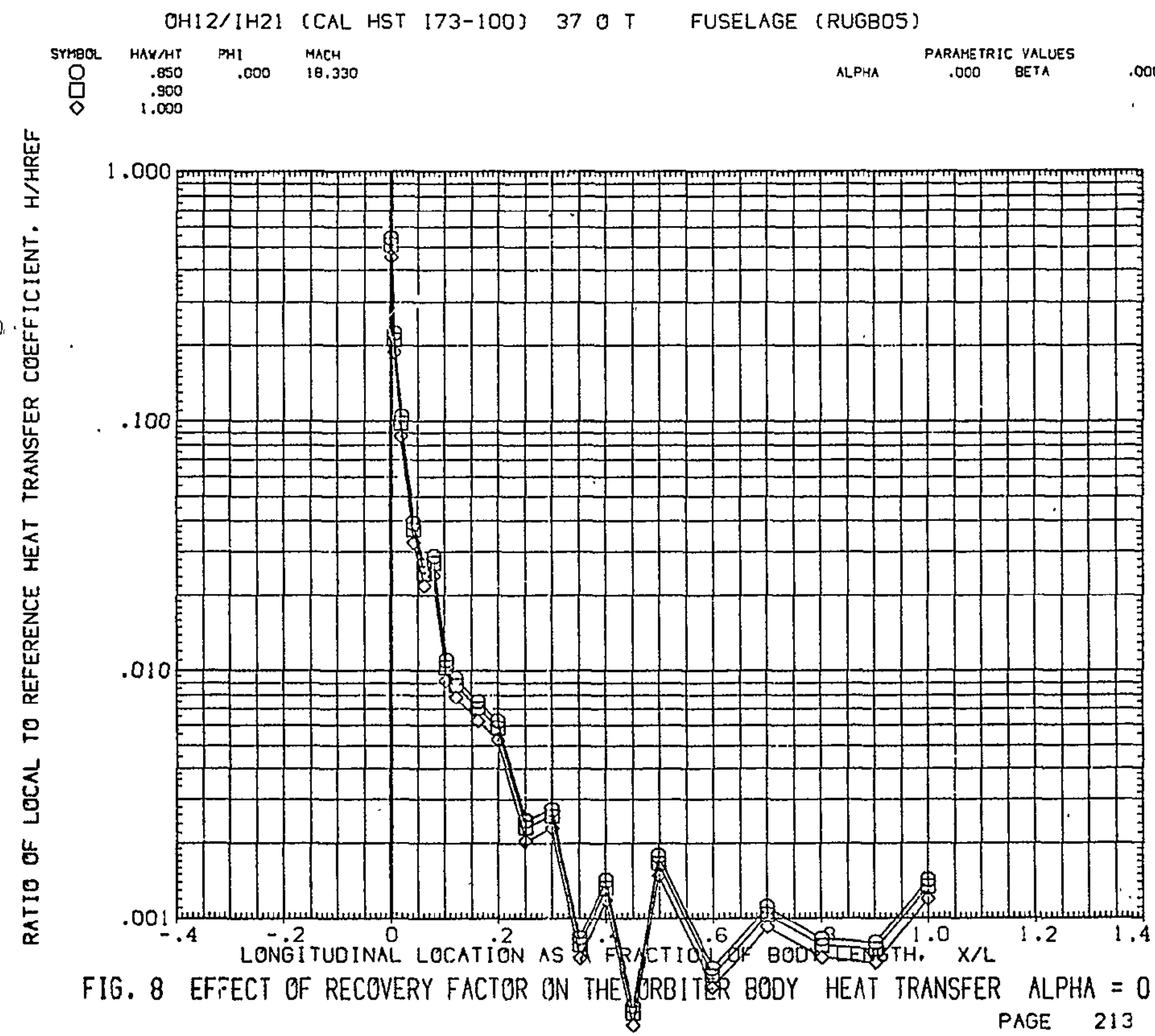

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

SYMBOL	HAW/HT	PHI	MACH
○	.850	25.000	18.330
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

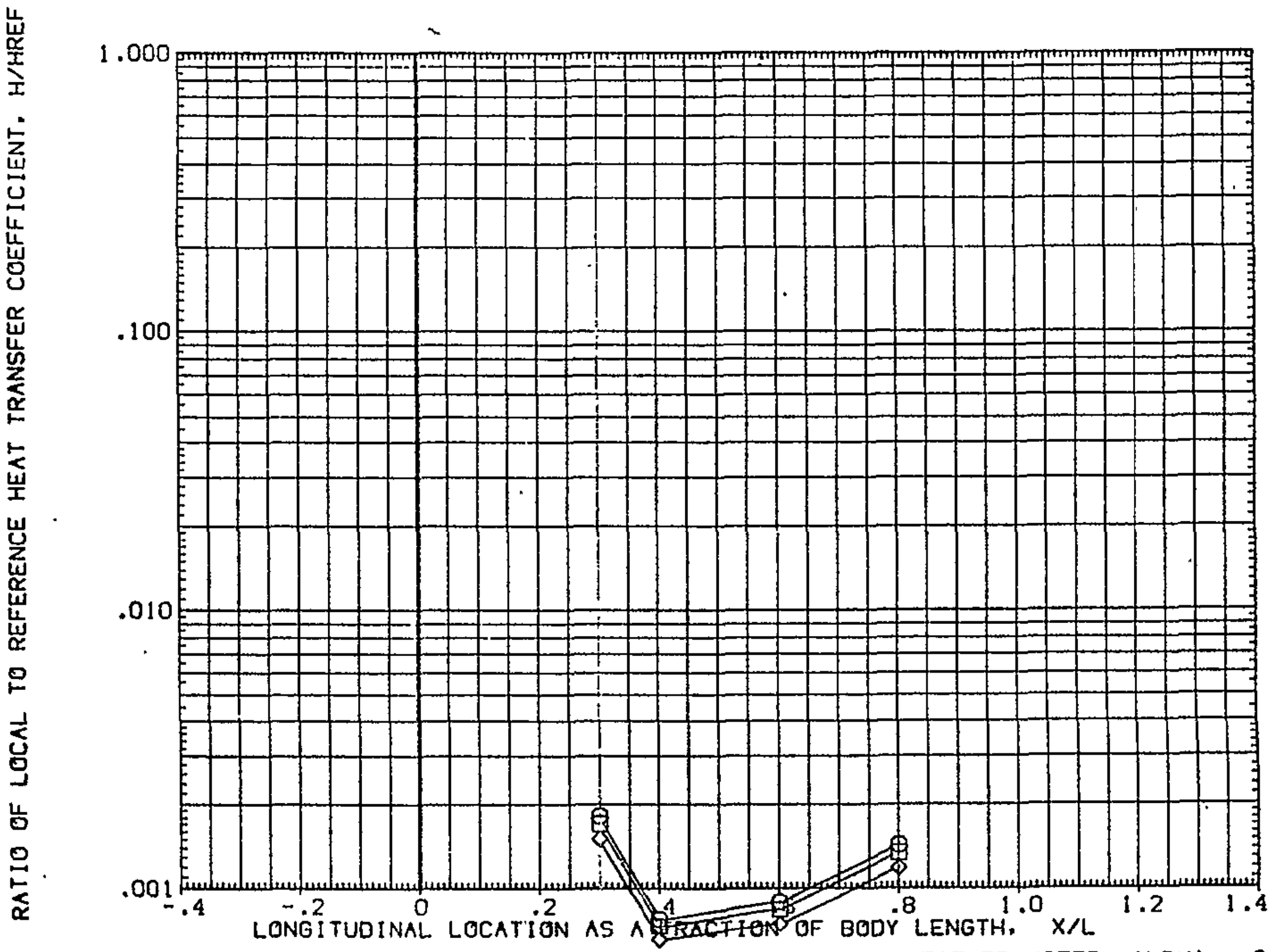

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

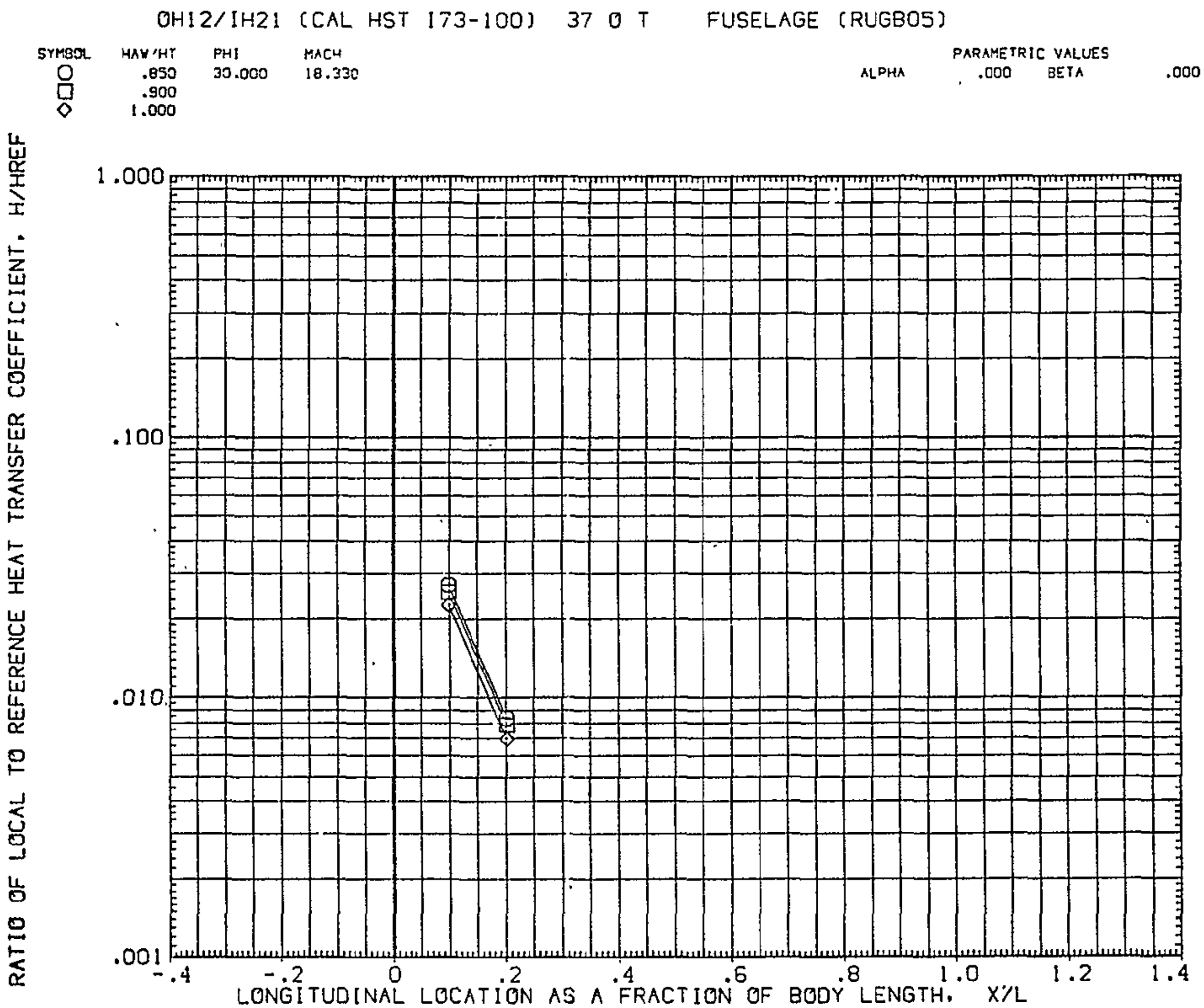

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

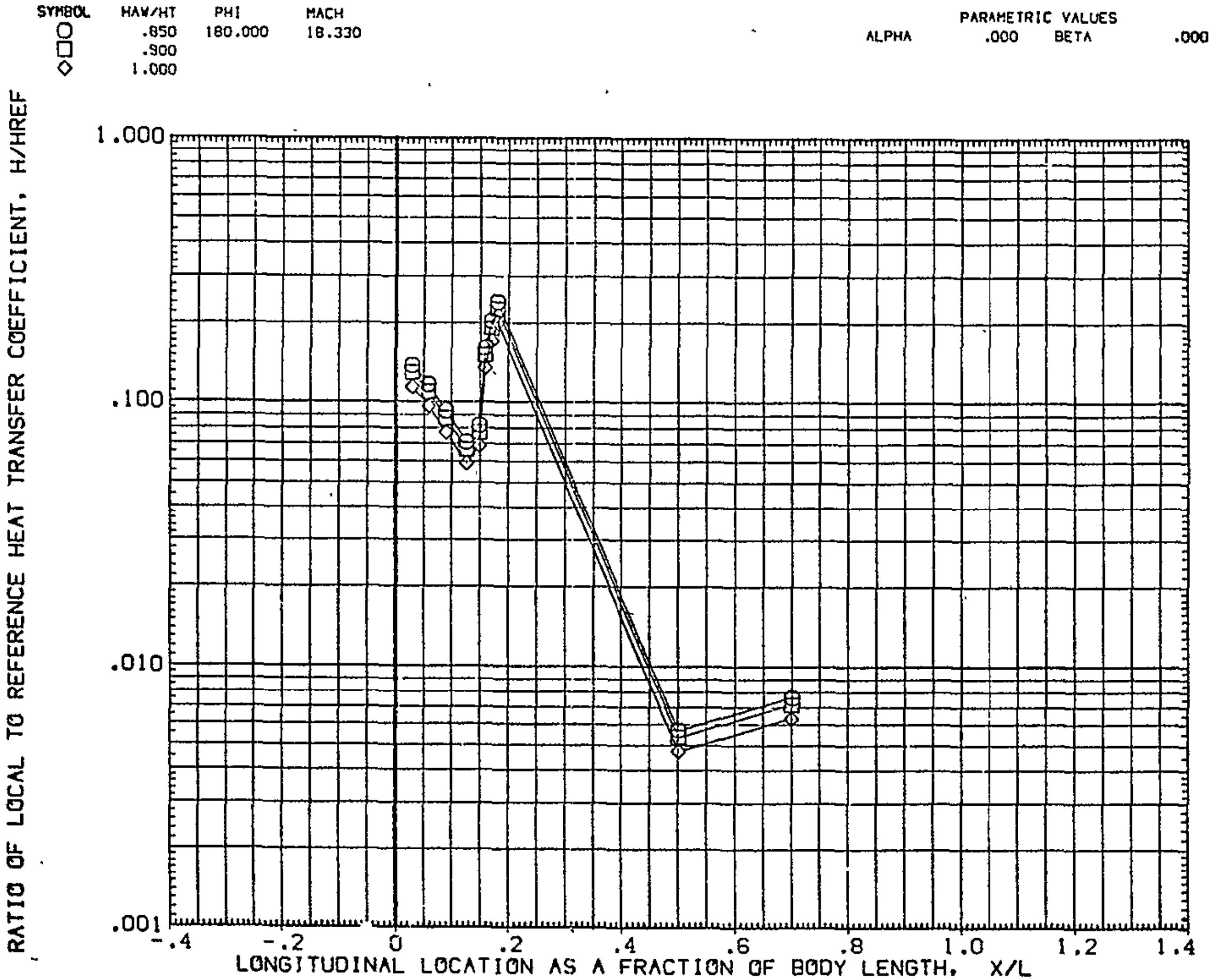

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T FUSELAGE (RUGB05)

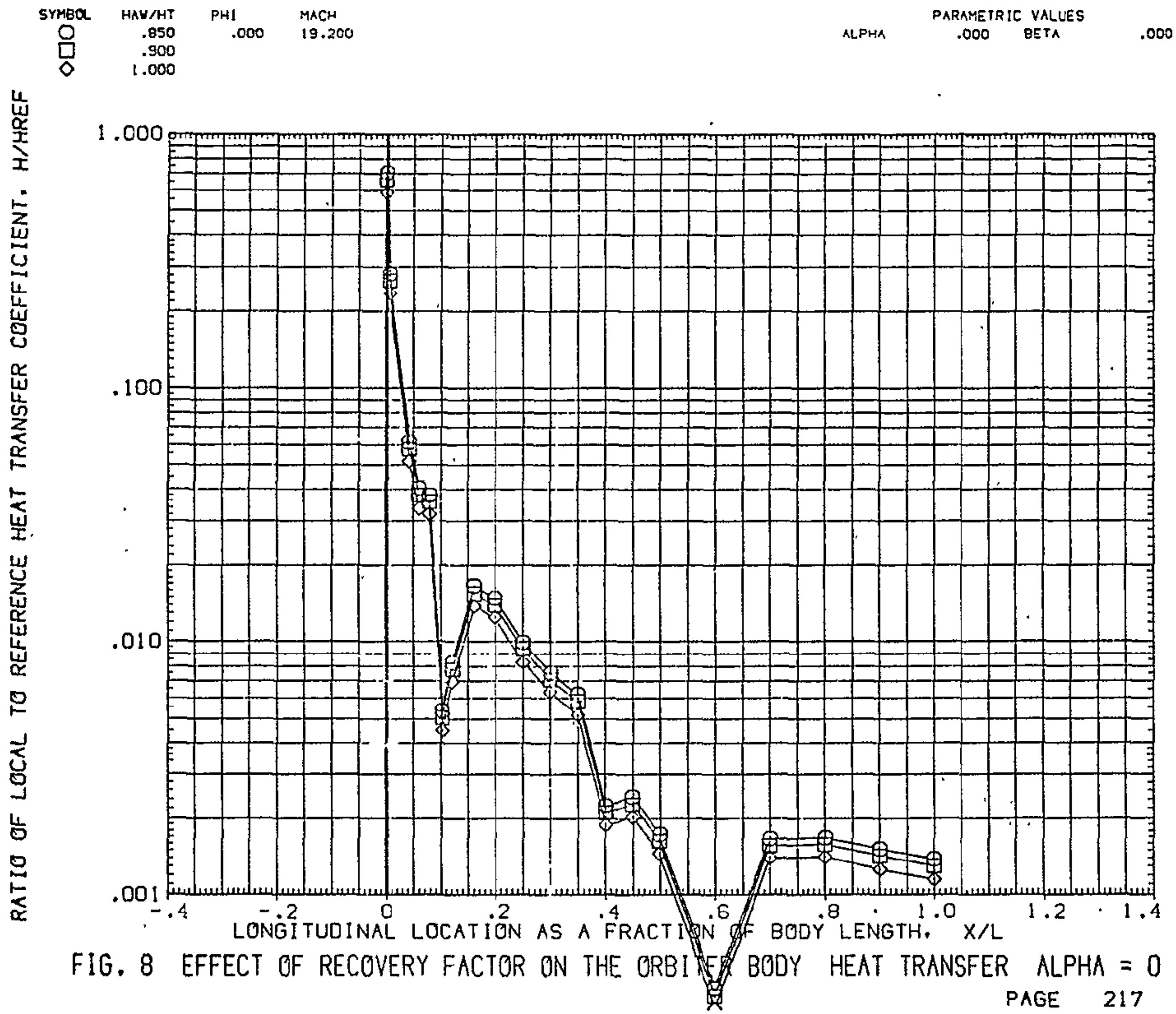

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

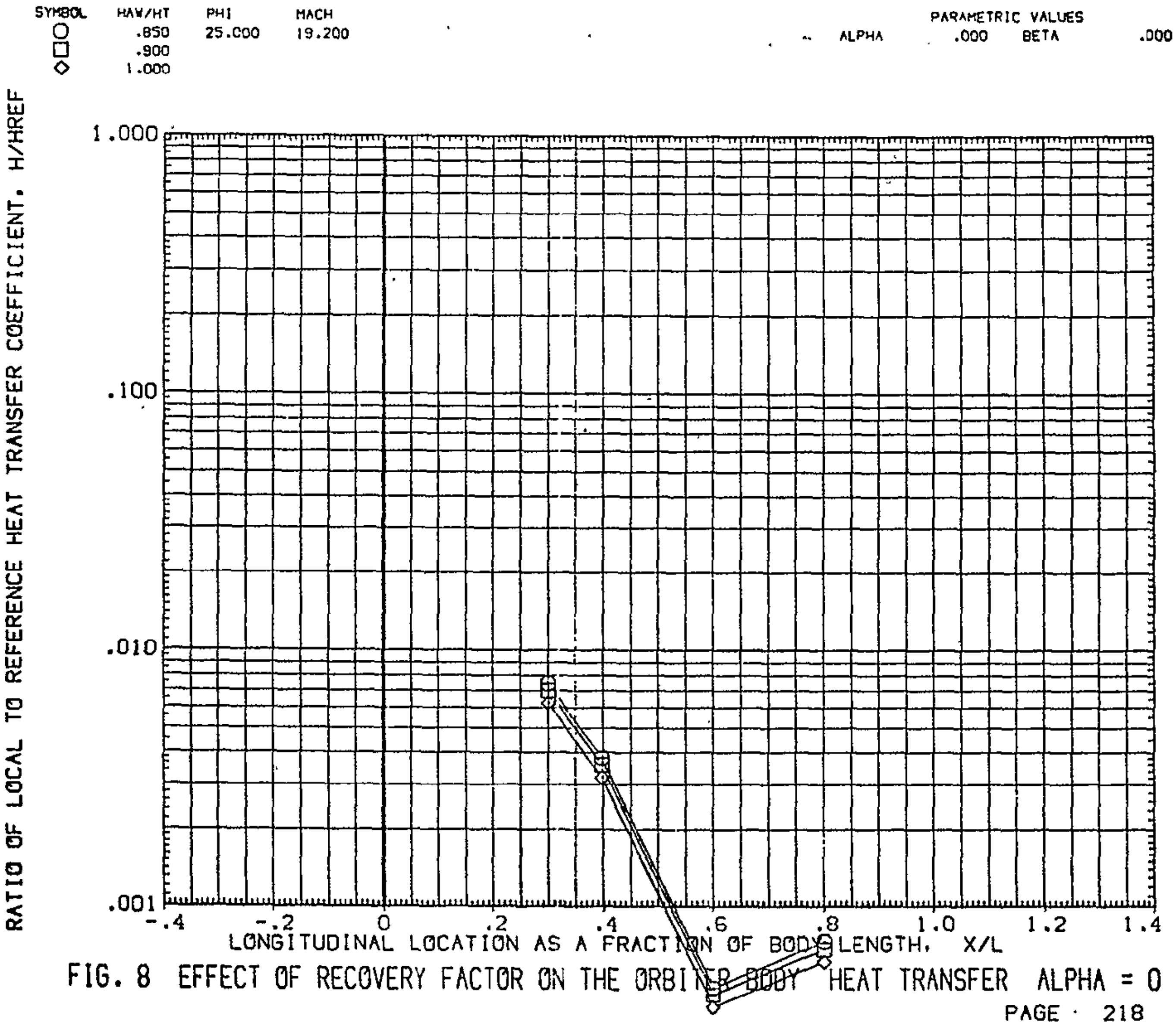

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

0H12/IH21 (CAL HST I73-100) 37 0 T FUSELAGE (RUGB05)

SYMBOL	HAW/HT	PHI	MACH
○	.850	30.000	19.200
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

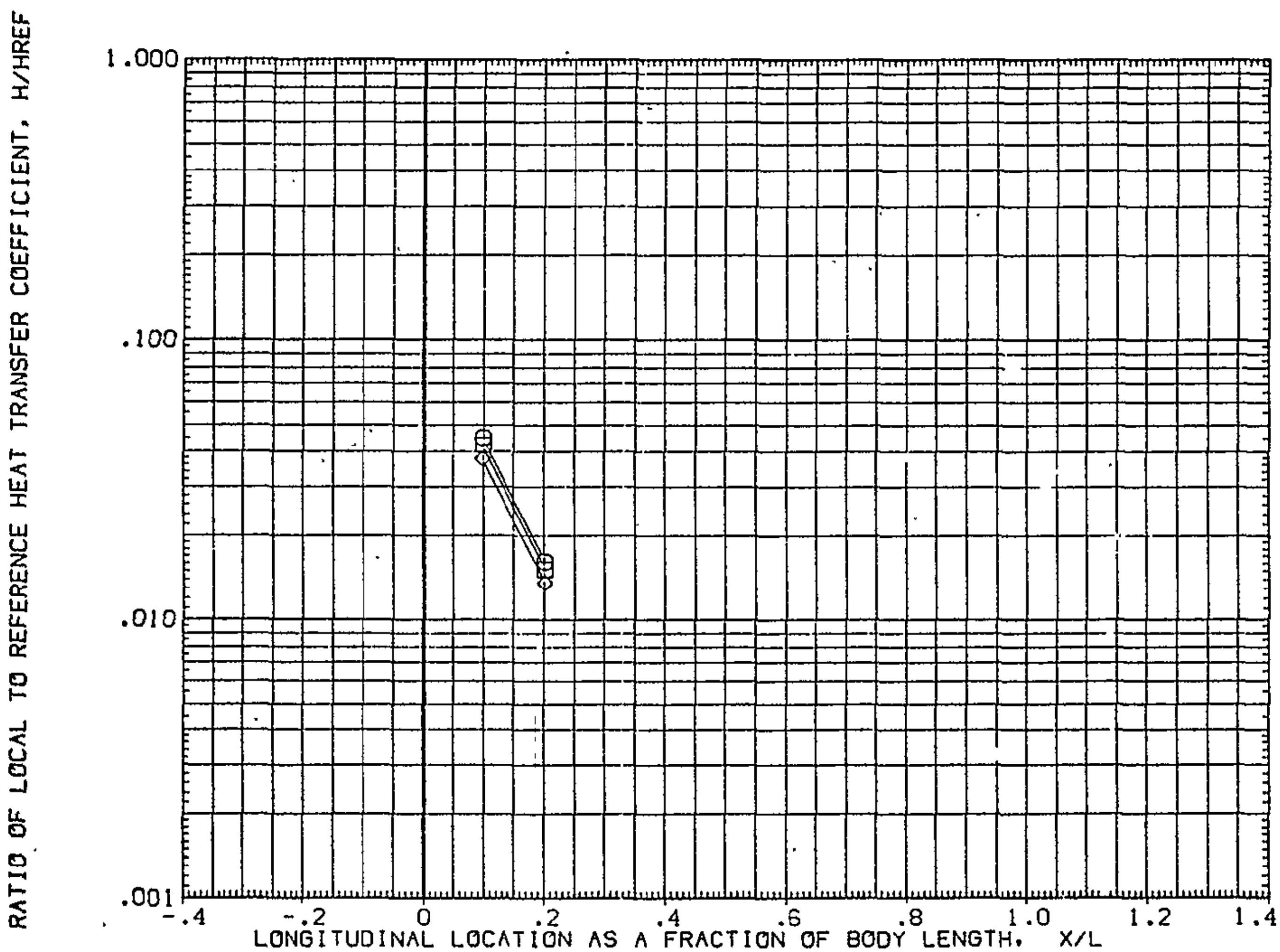

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

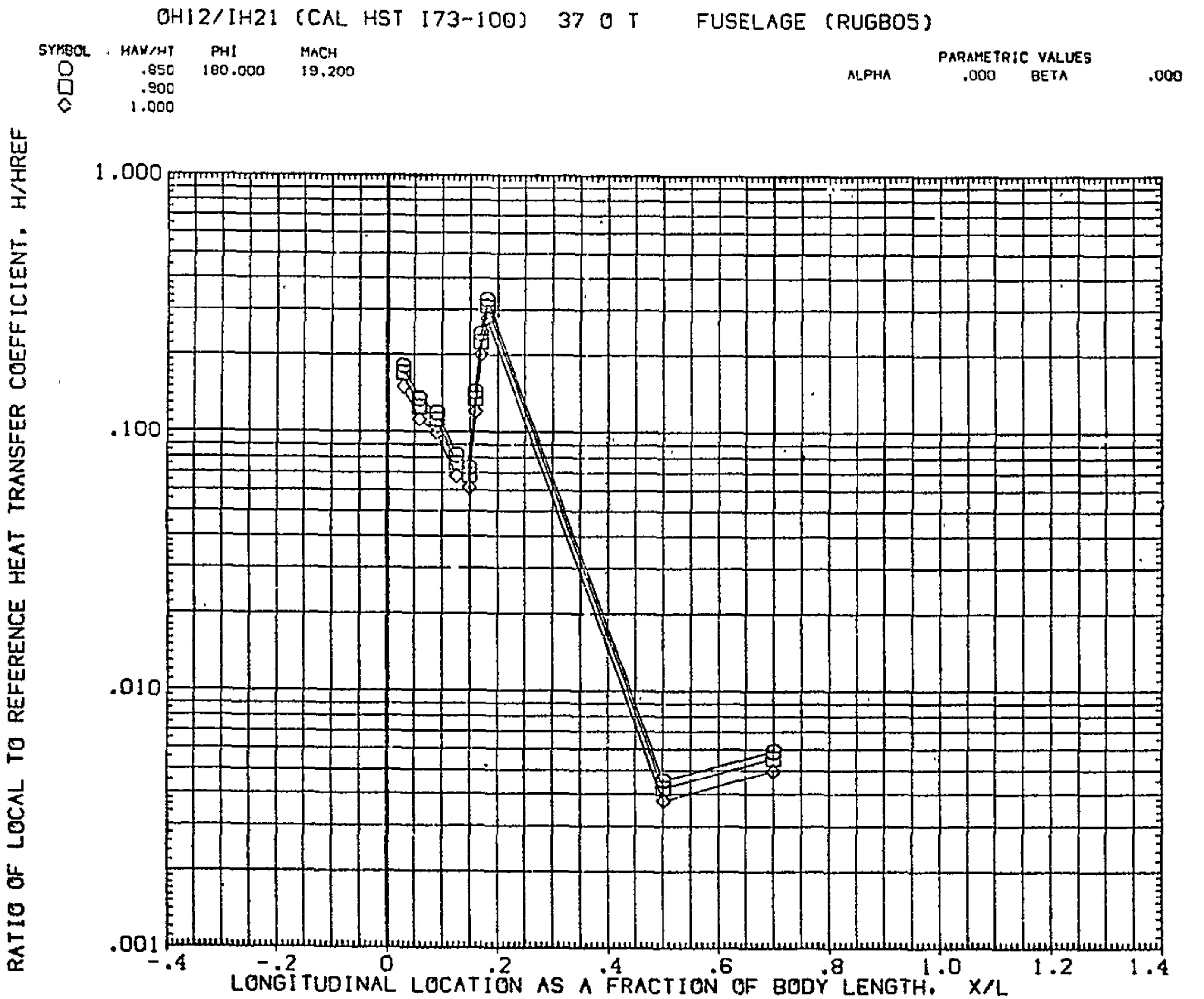

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

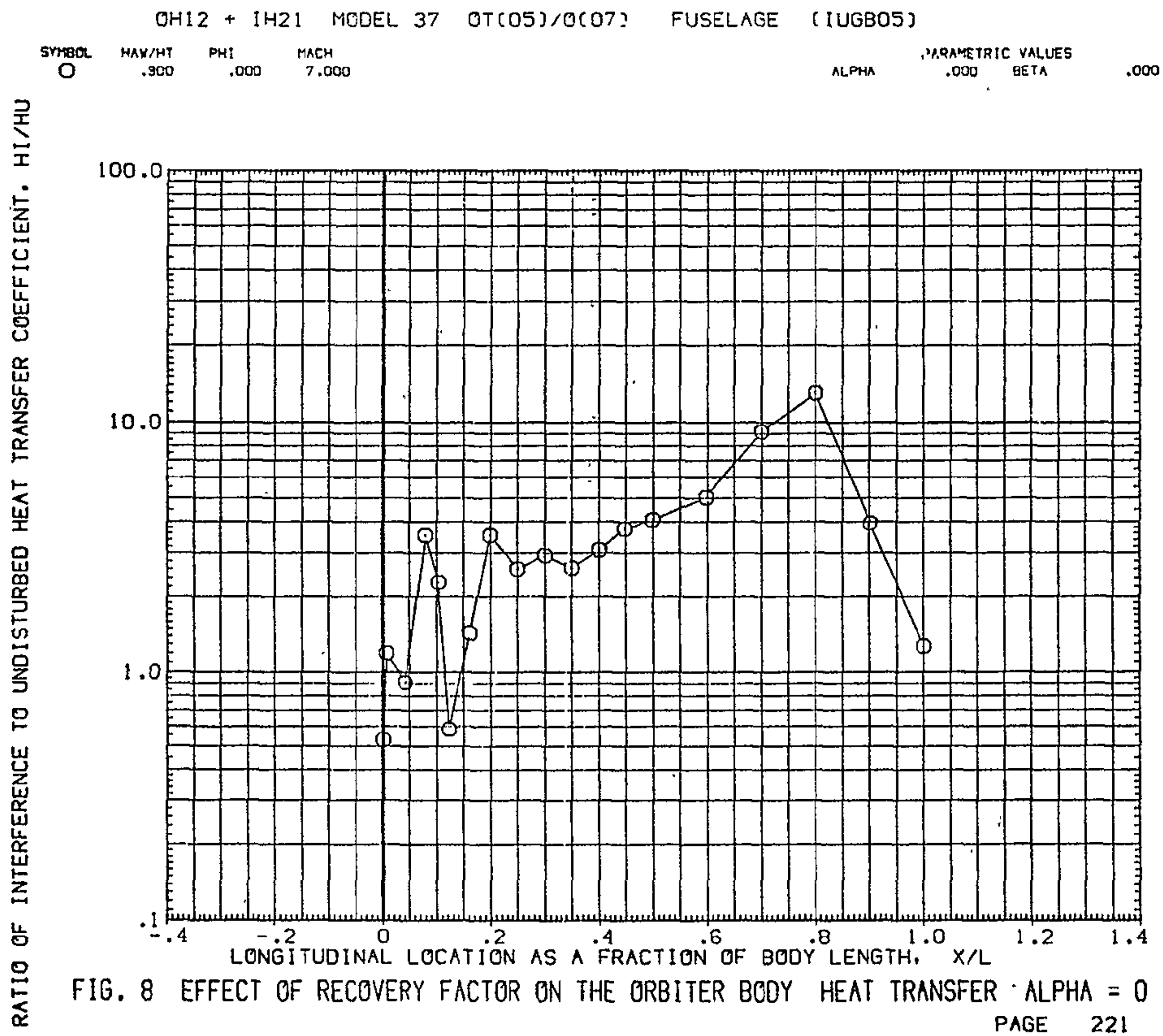

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	25.000	7.000

PARAMETRIC VALUES
ALPHA .000 BETA .000

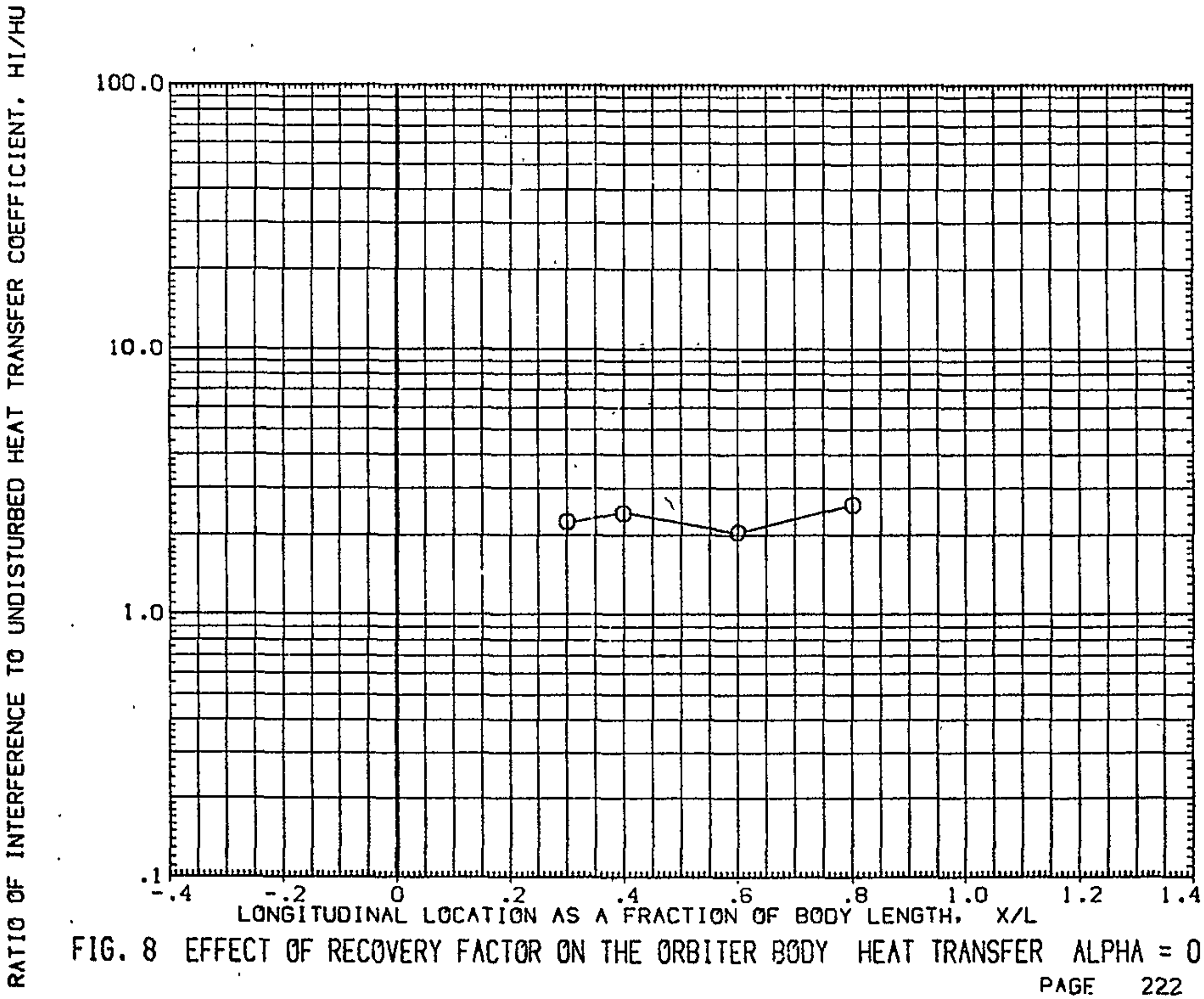

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	30.000	7.000	ALPHA	.000	BETA	.000

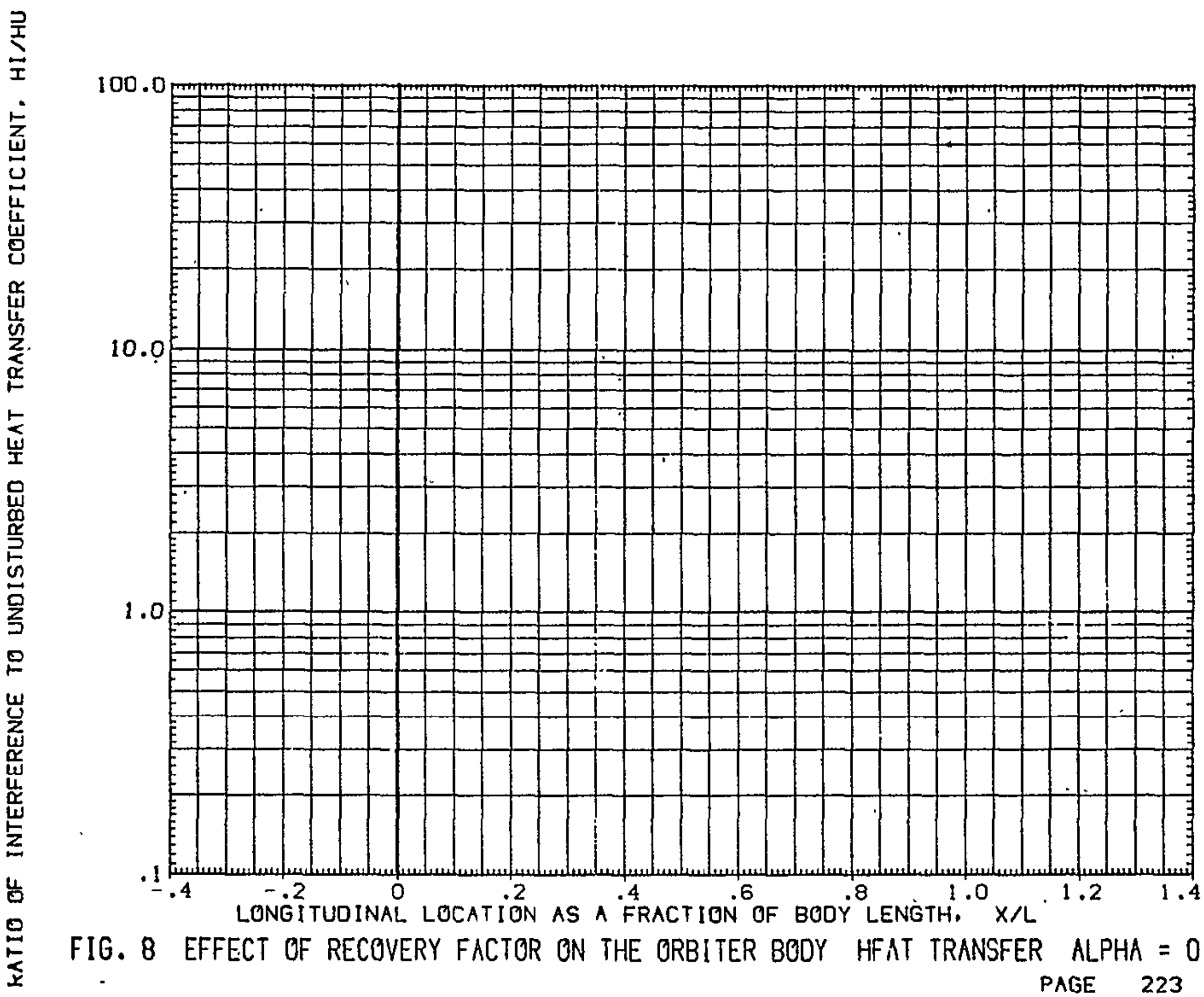

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	180.000	7.000

PARAMETRIC VALUES

ALPHA .000 BETA .000

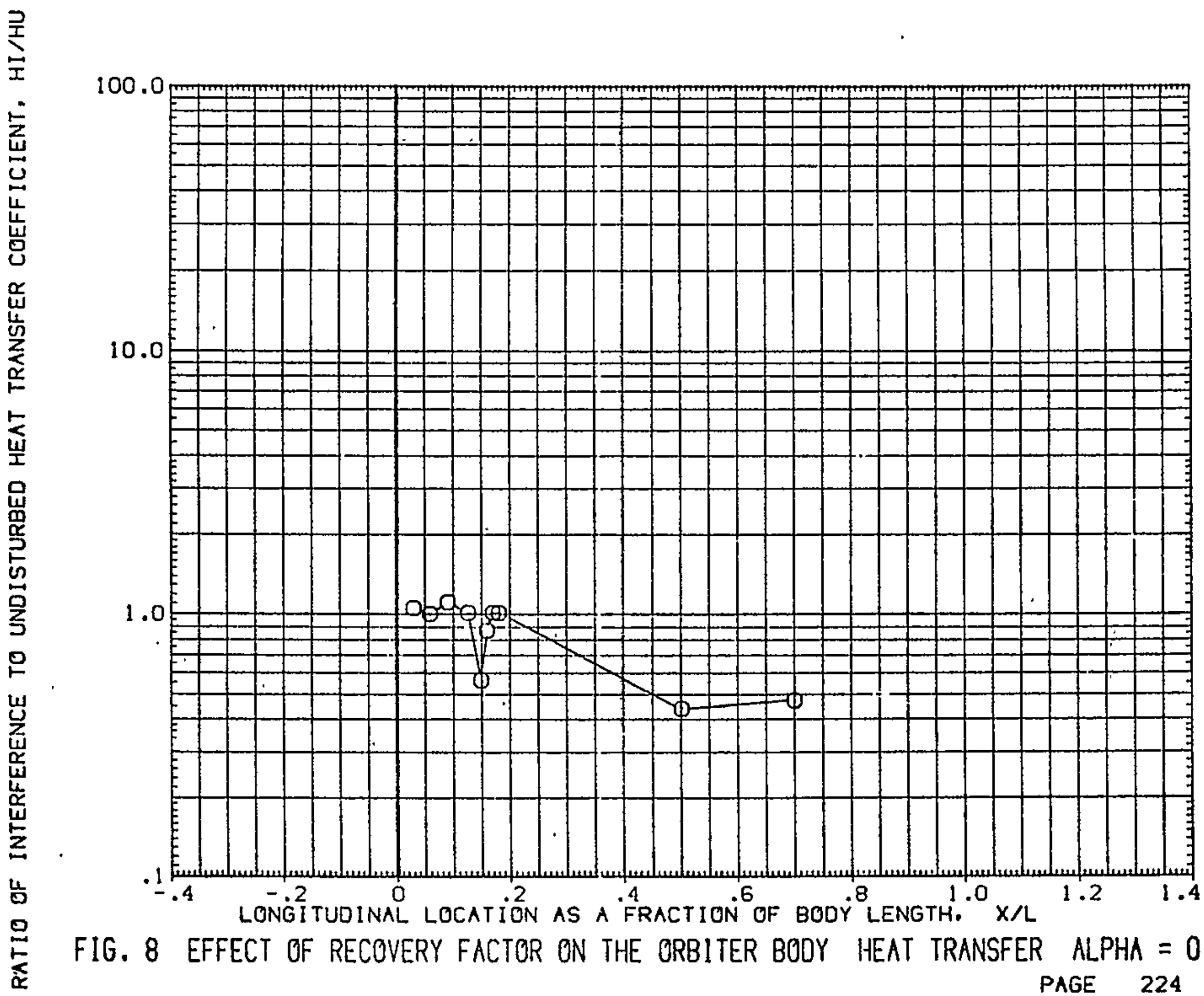

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

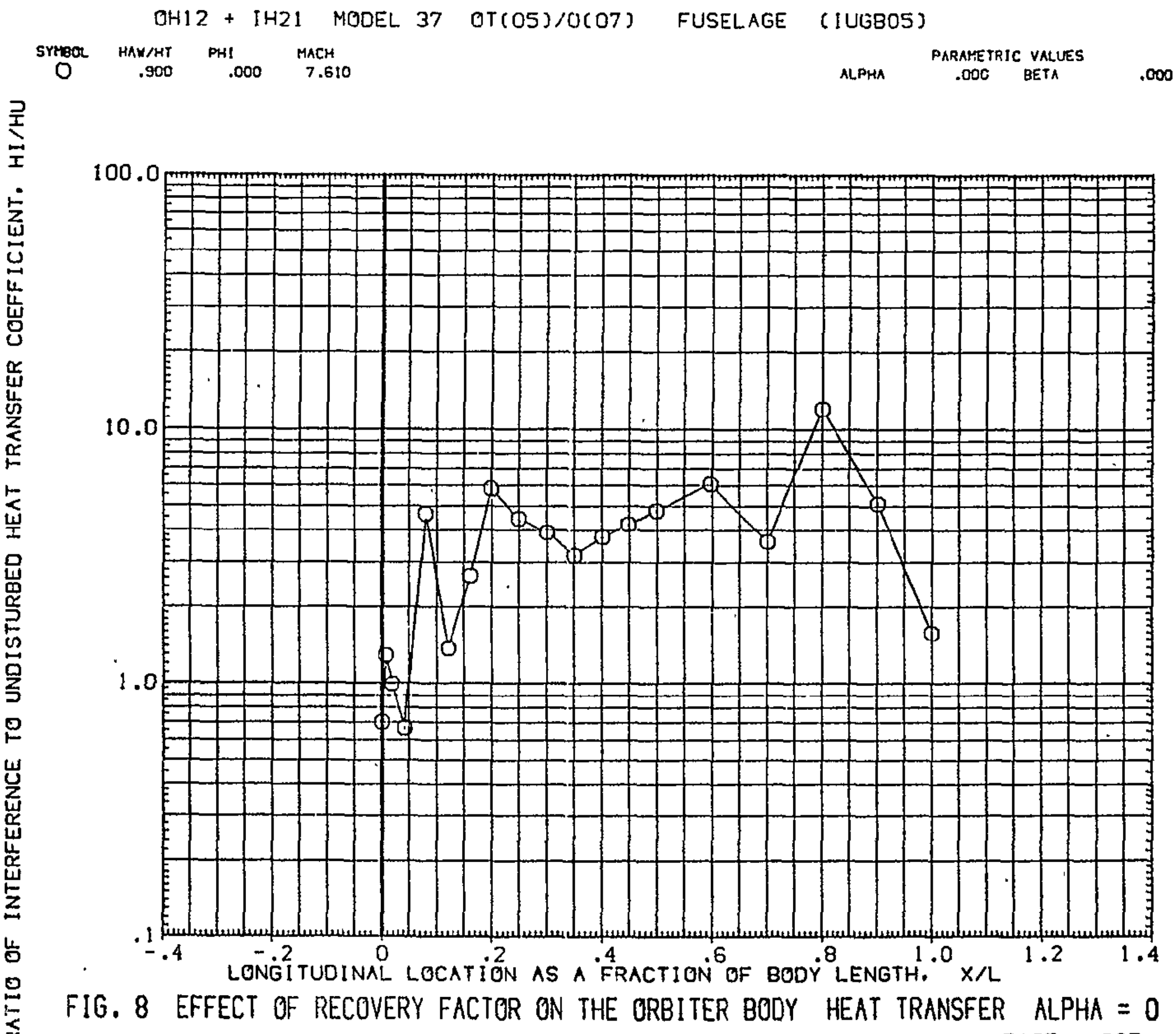

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

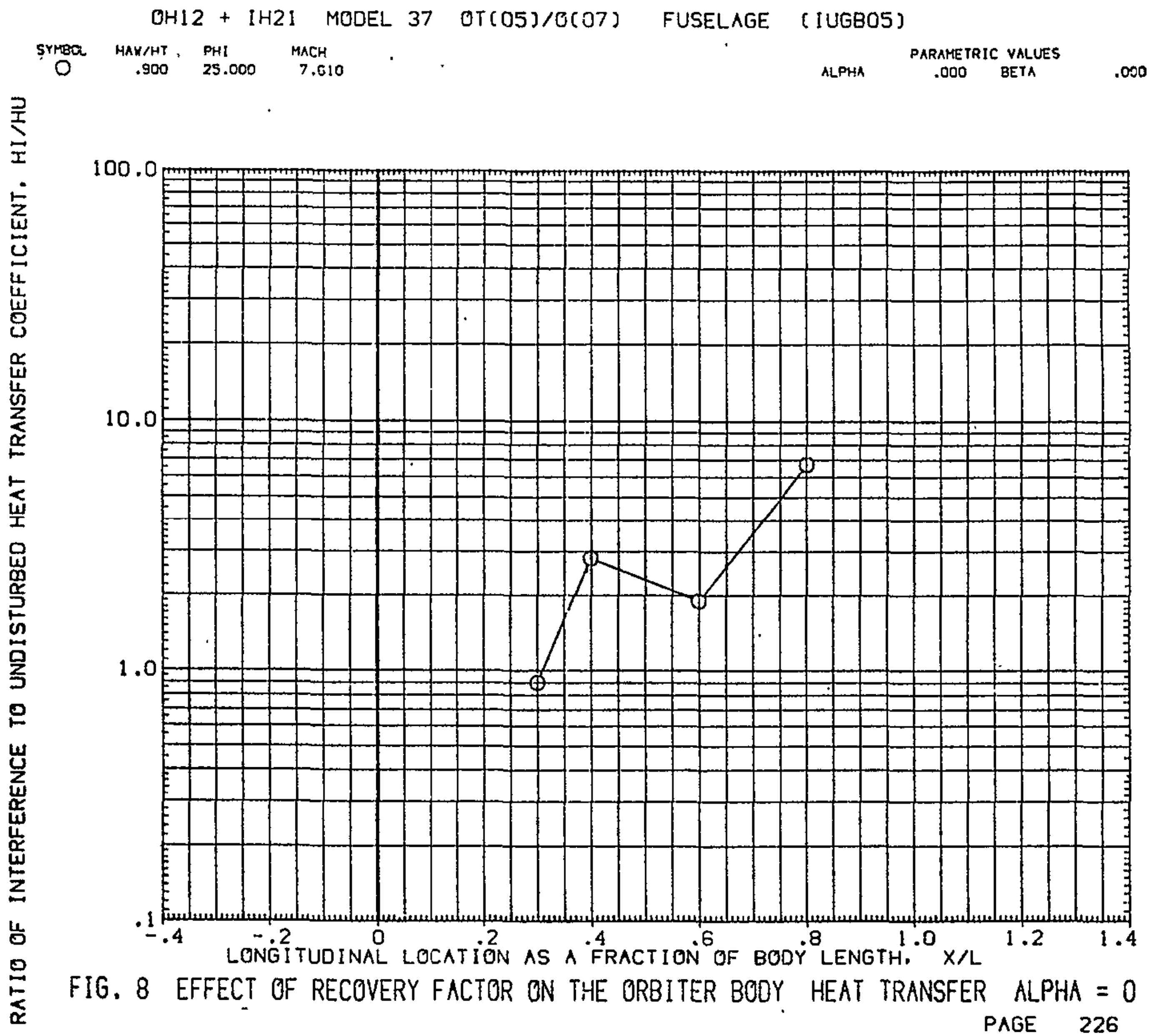

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

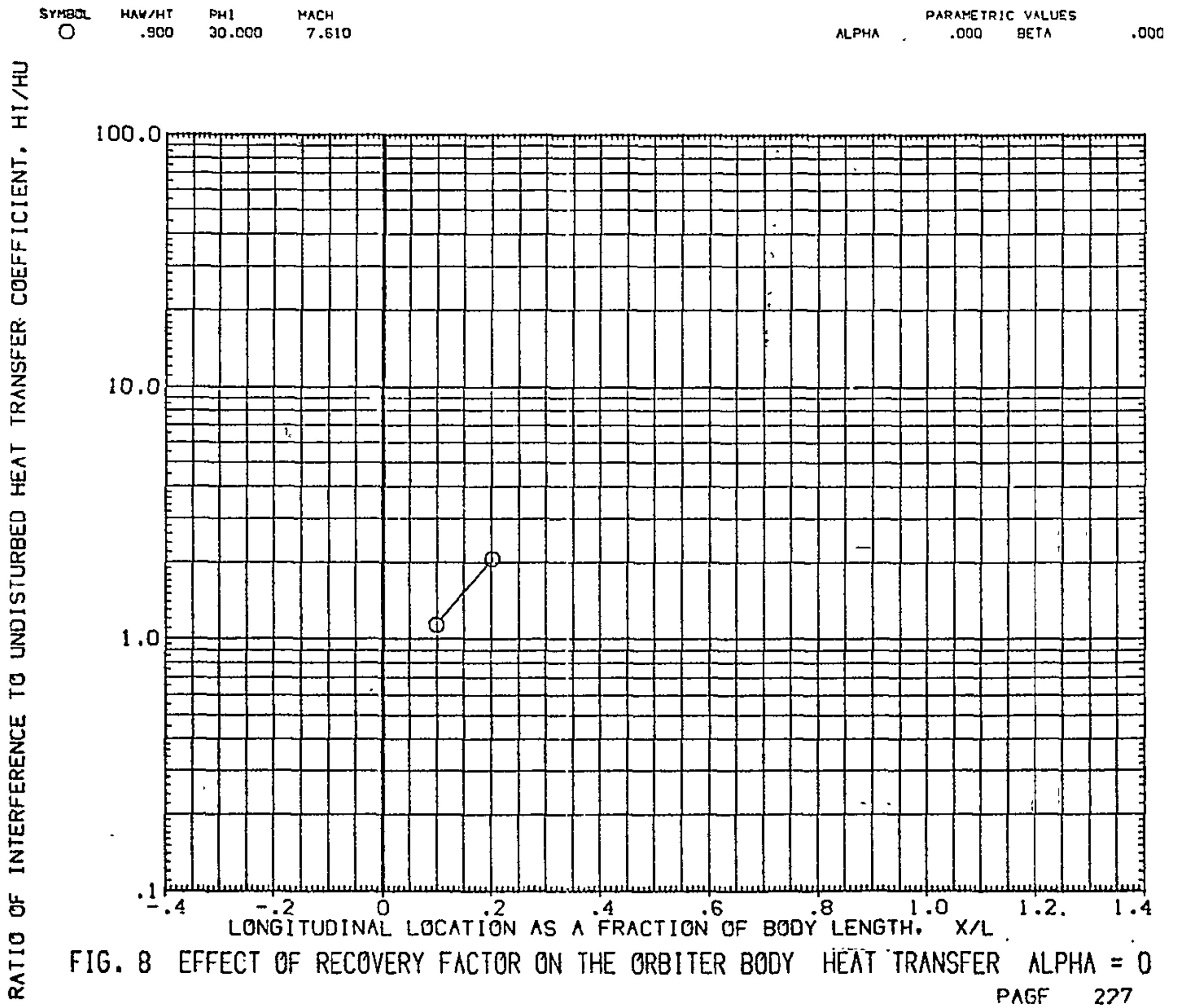

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
O	.900	180.000	7.610	ALPHA	.000	BETA	.000

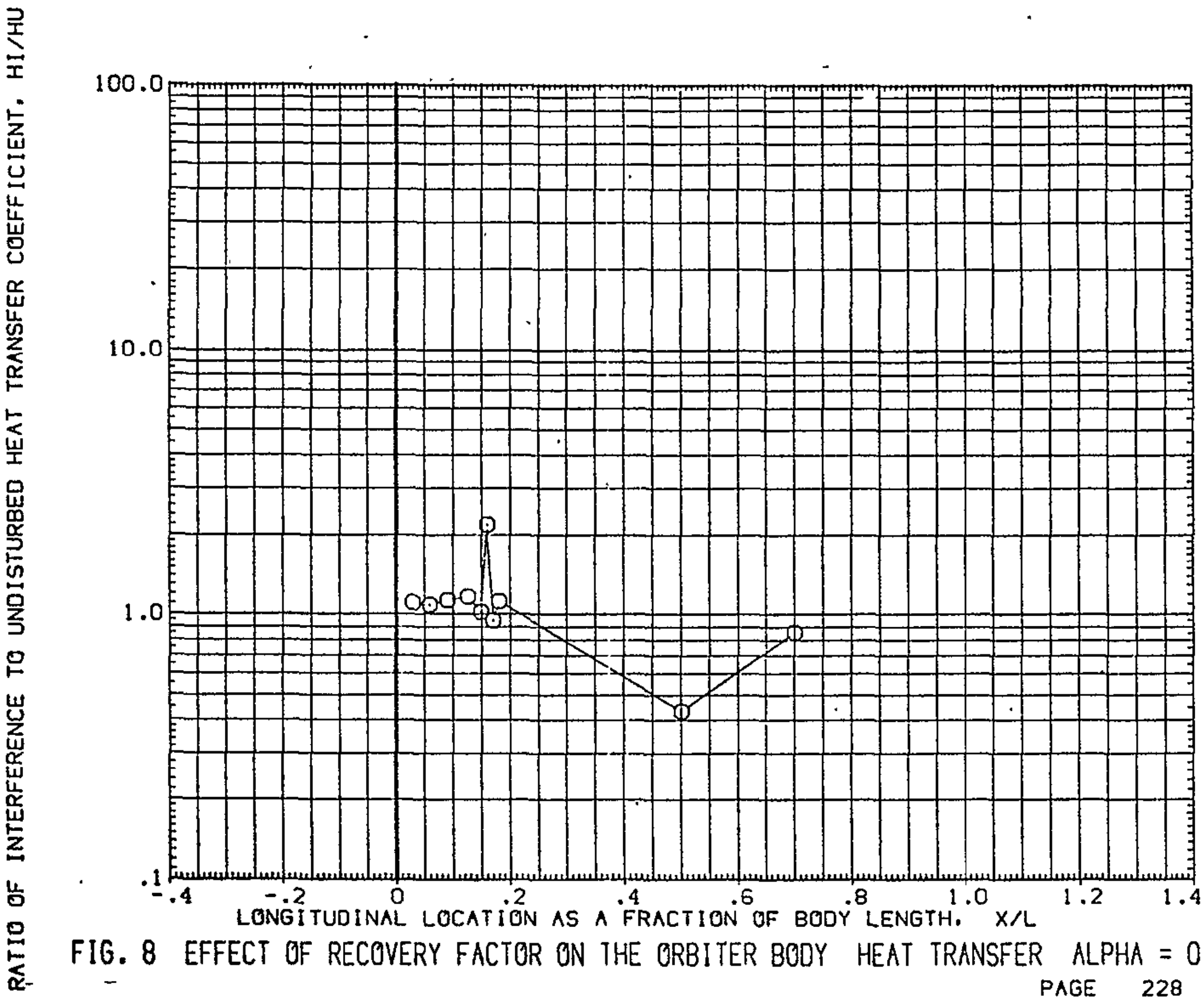

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	.000	18.300

PARAMETRIC VALUES

ALPHA .000 BETA .000

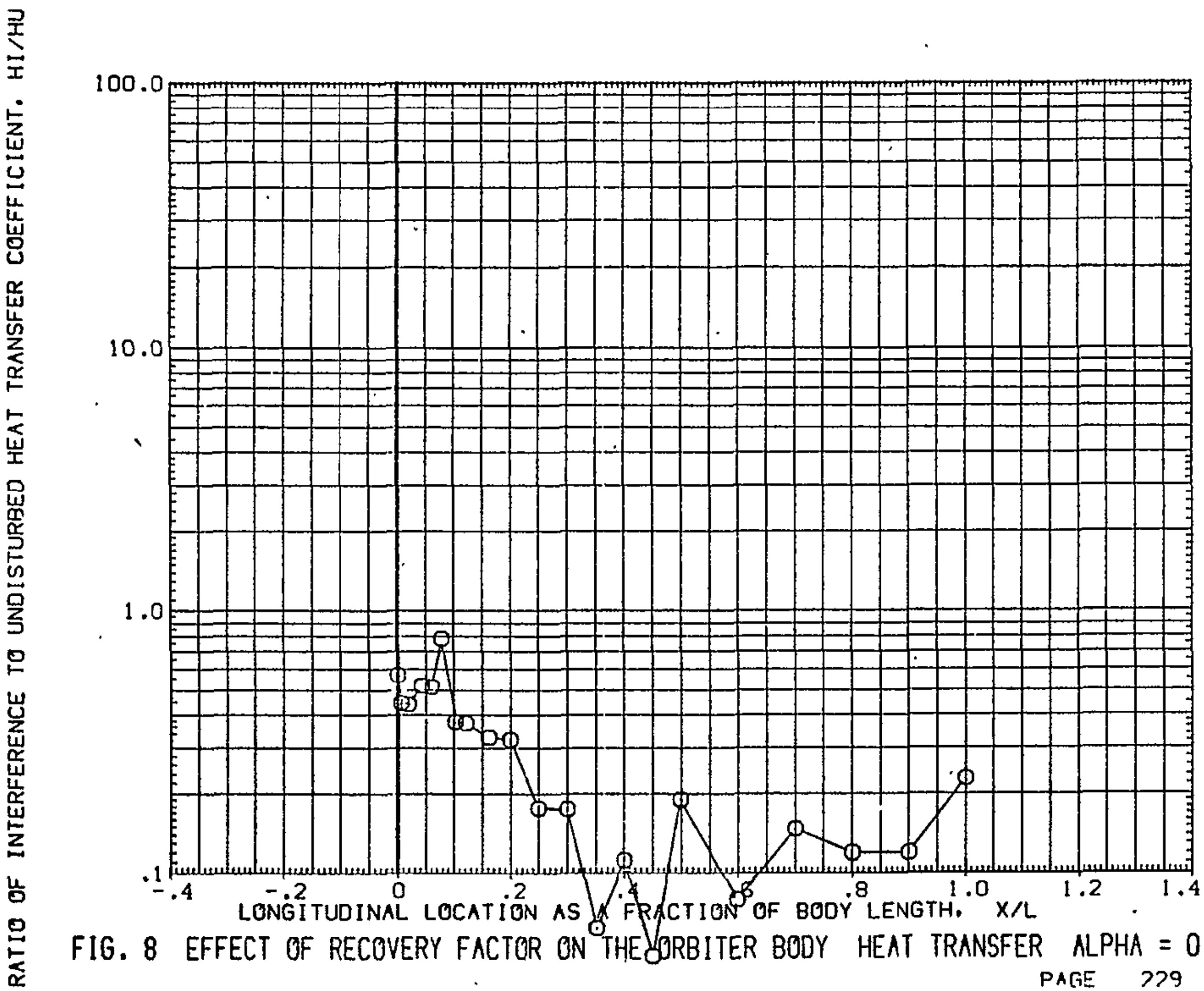

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUG805)

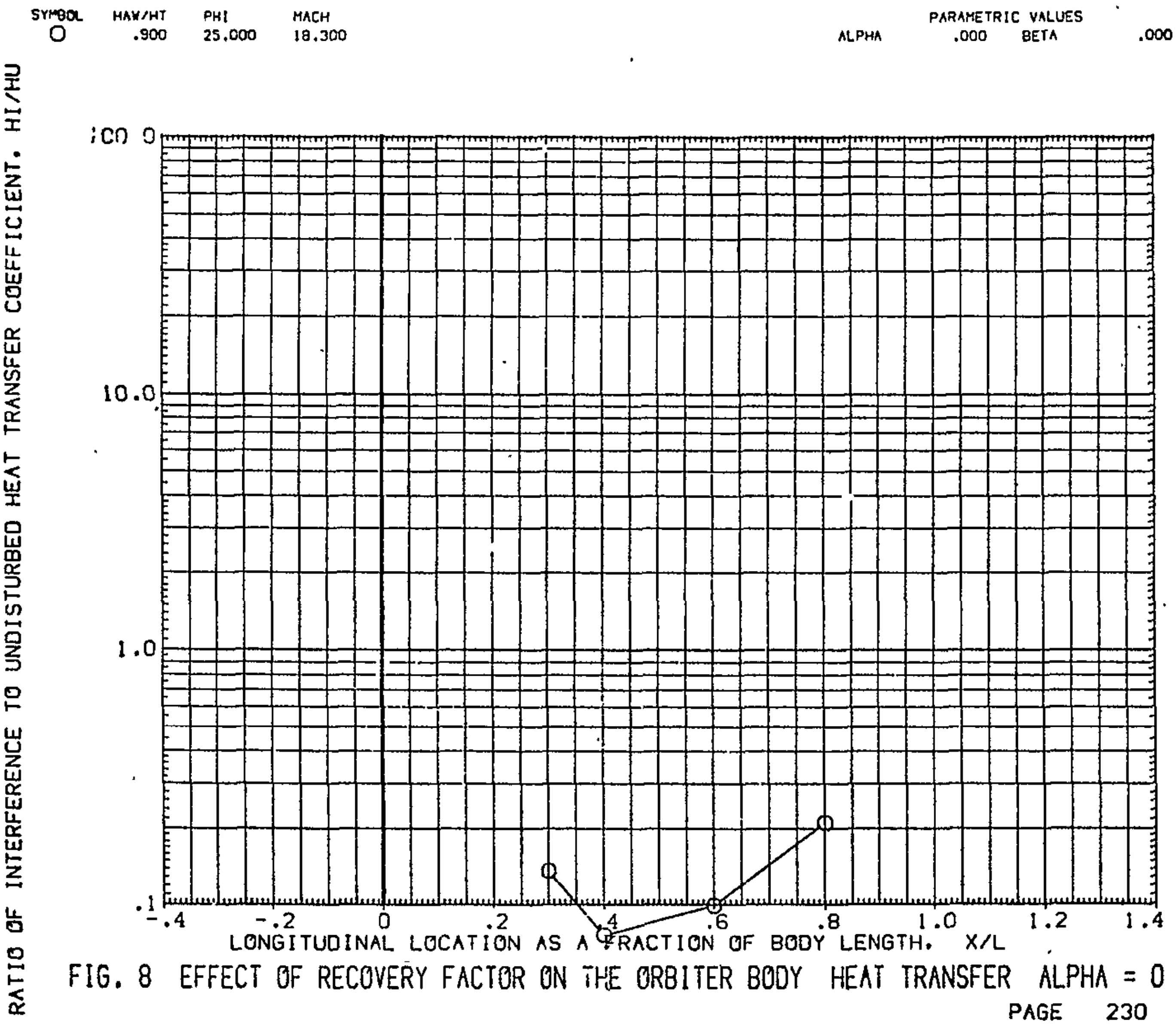

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

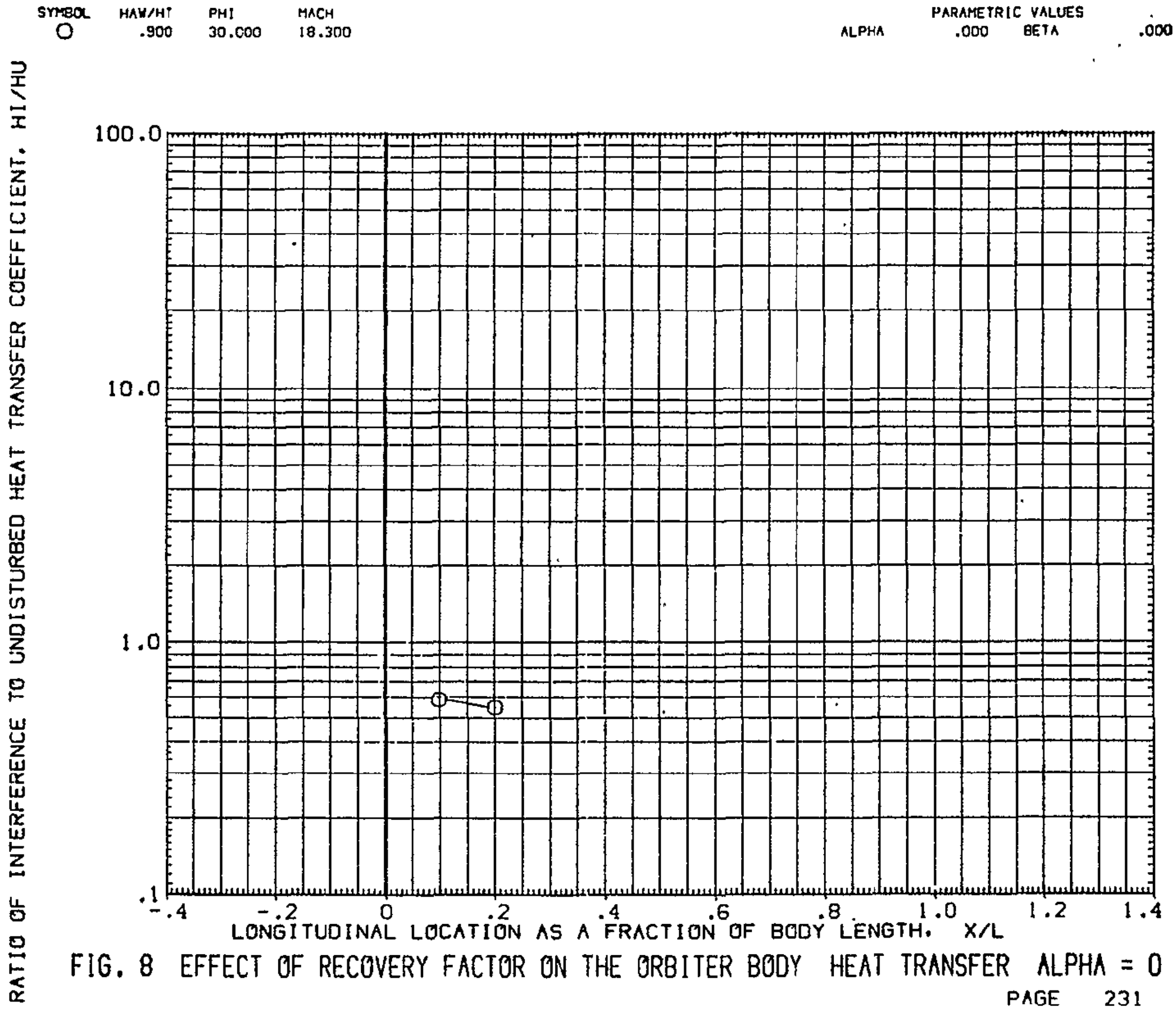

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

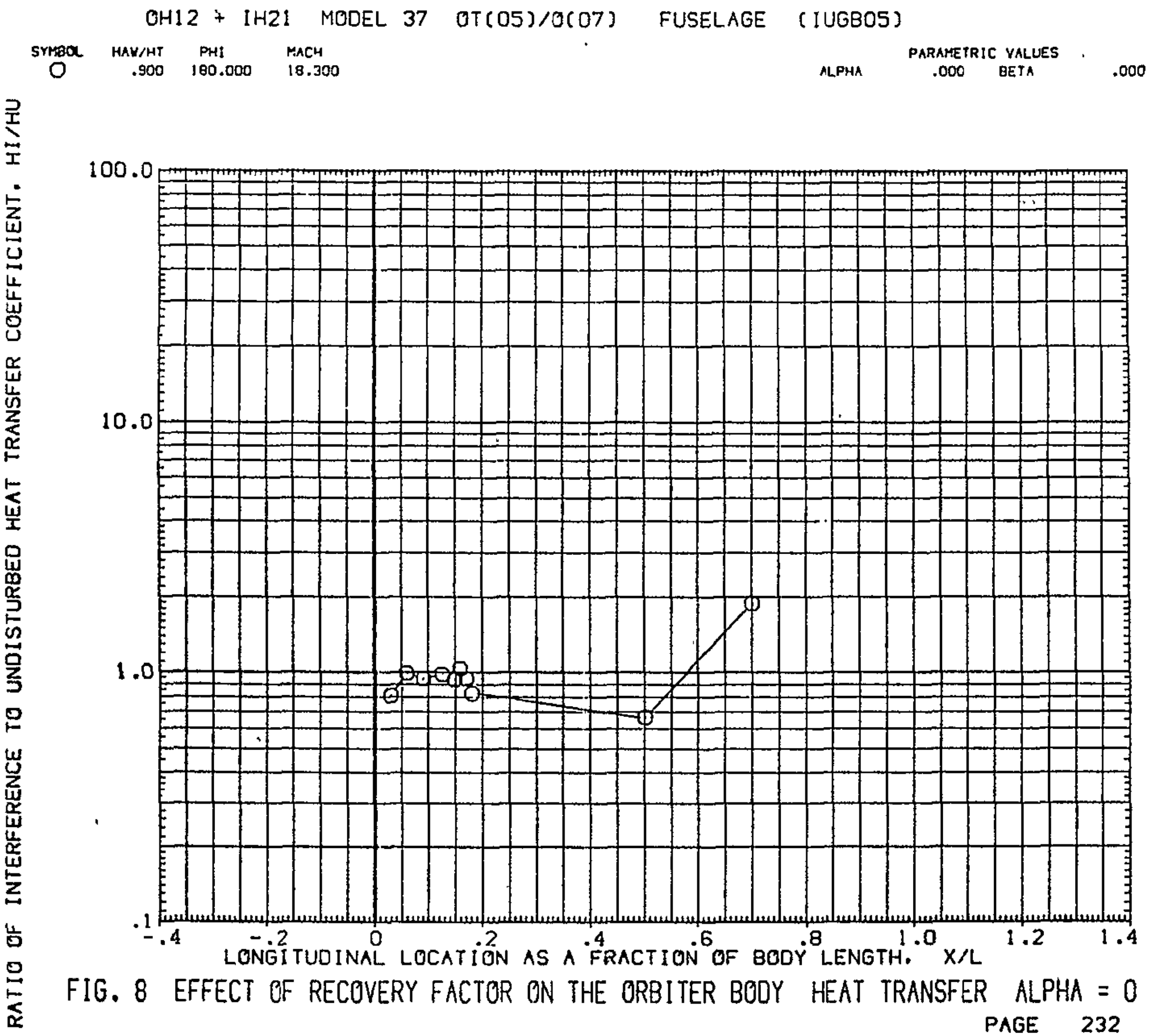

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH
O	.900	.000	19.180

PARAMETRIC VALUES

ALPHA .000 BETA .000

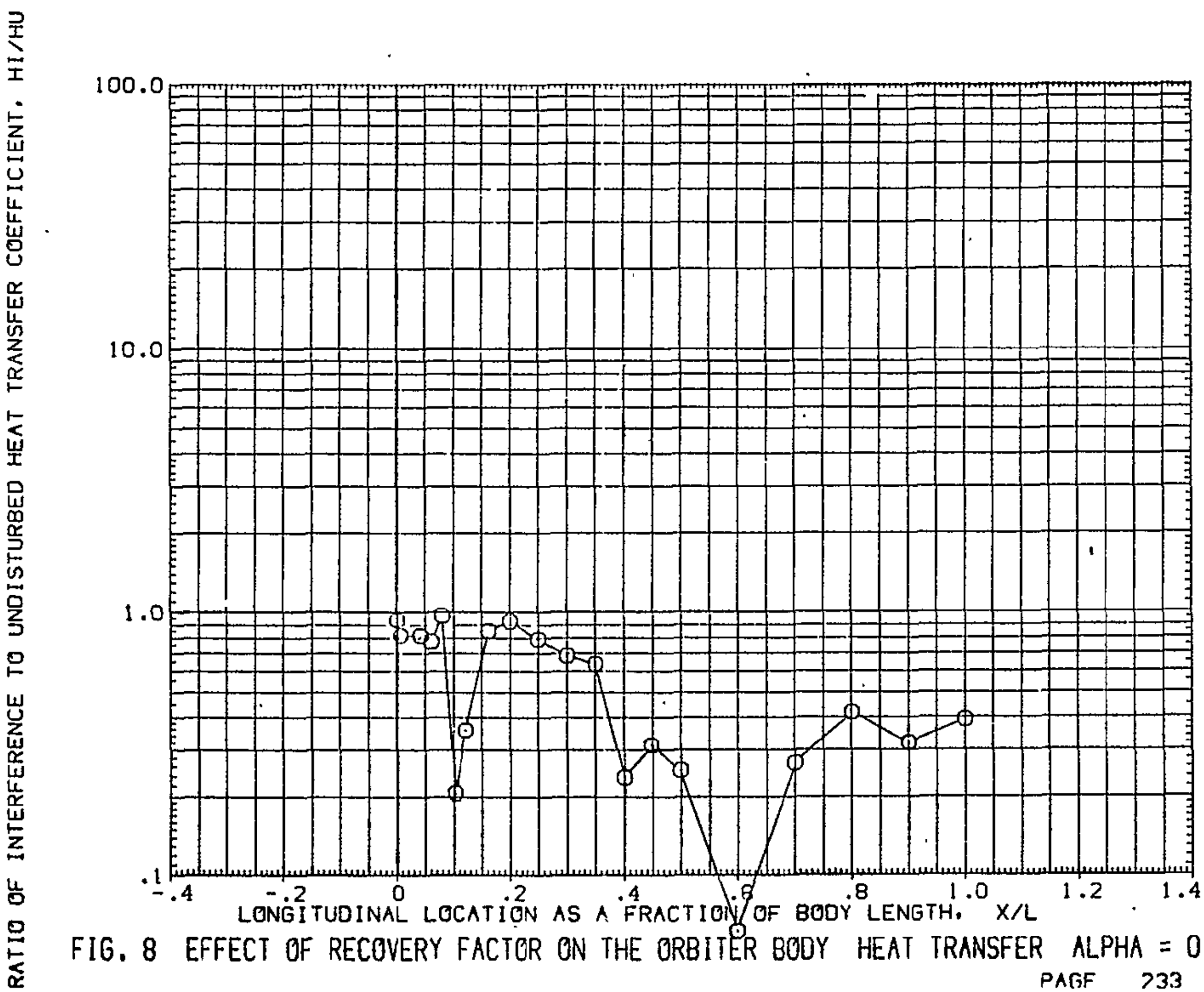

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

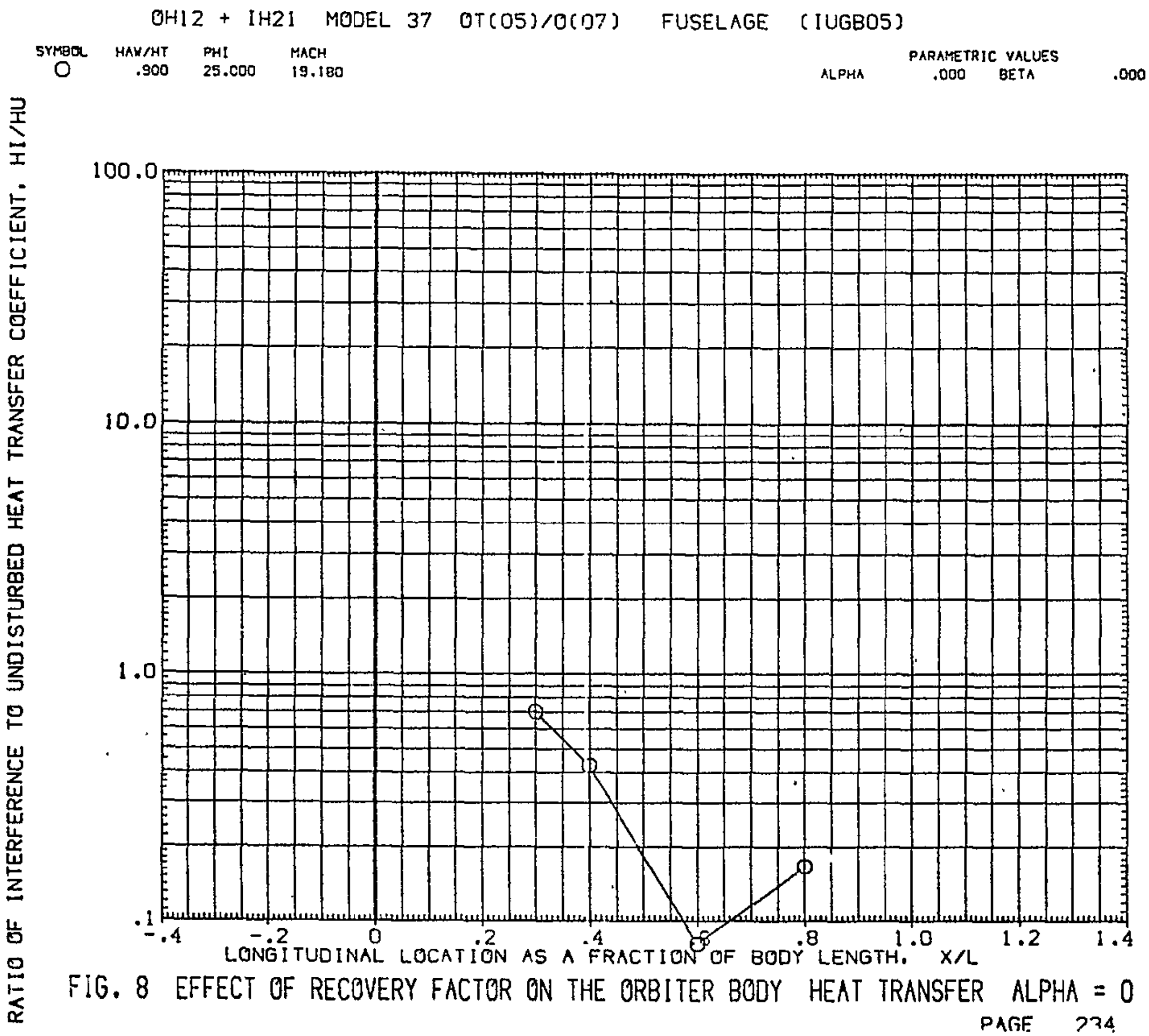

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

0H12 + IH21 MODEL 37 0T(05)/0(07) FUSELAGE (IUGB05)

SYMBOL	HAW/HT	PHI	MACH		PARAMETRIC VALUES		
○	.900	30.000	19.180	ALPHA	.000	BETA	.000

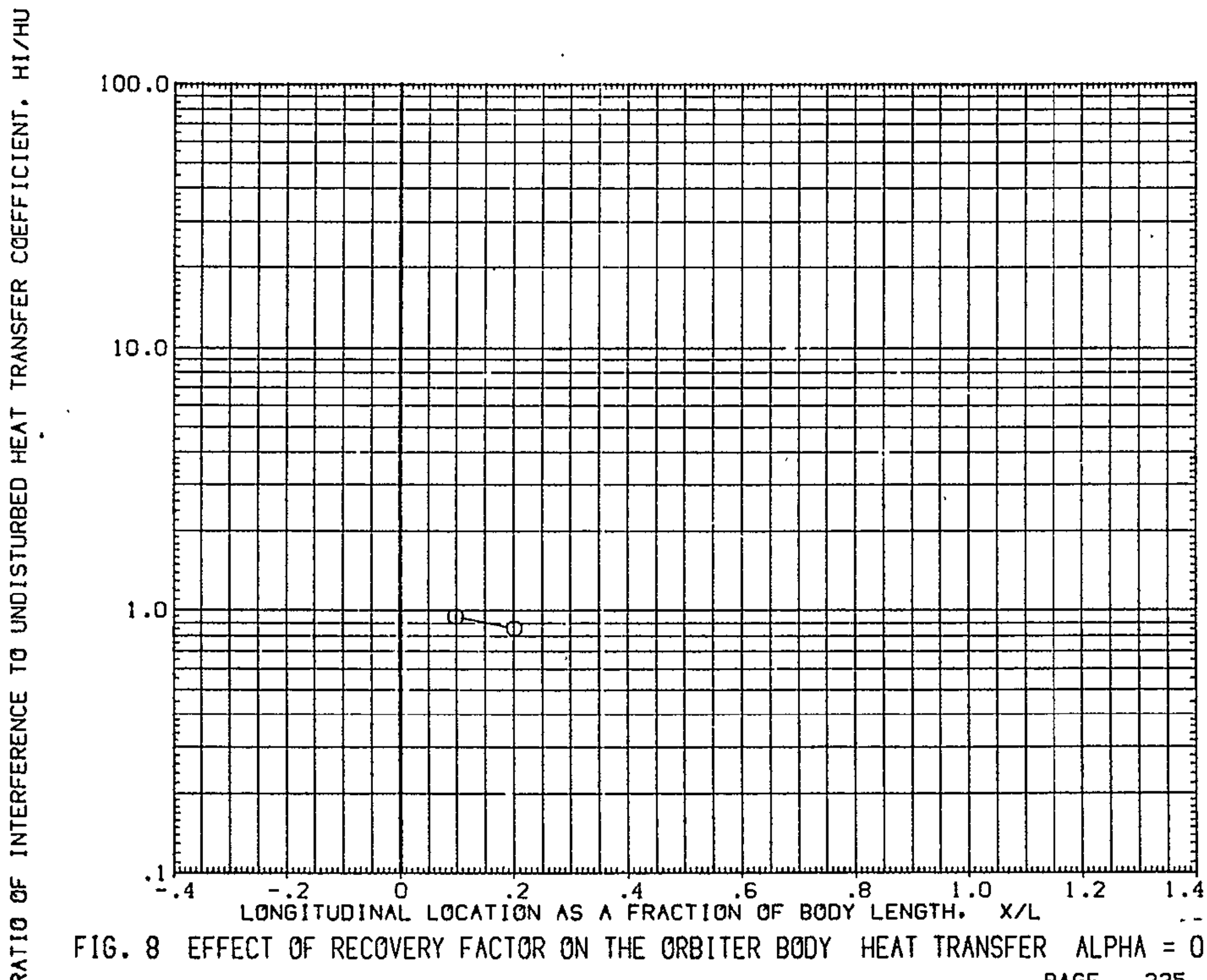

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

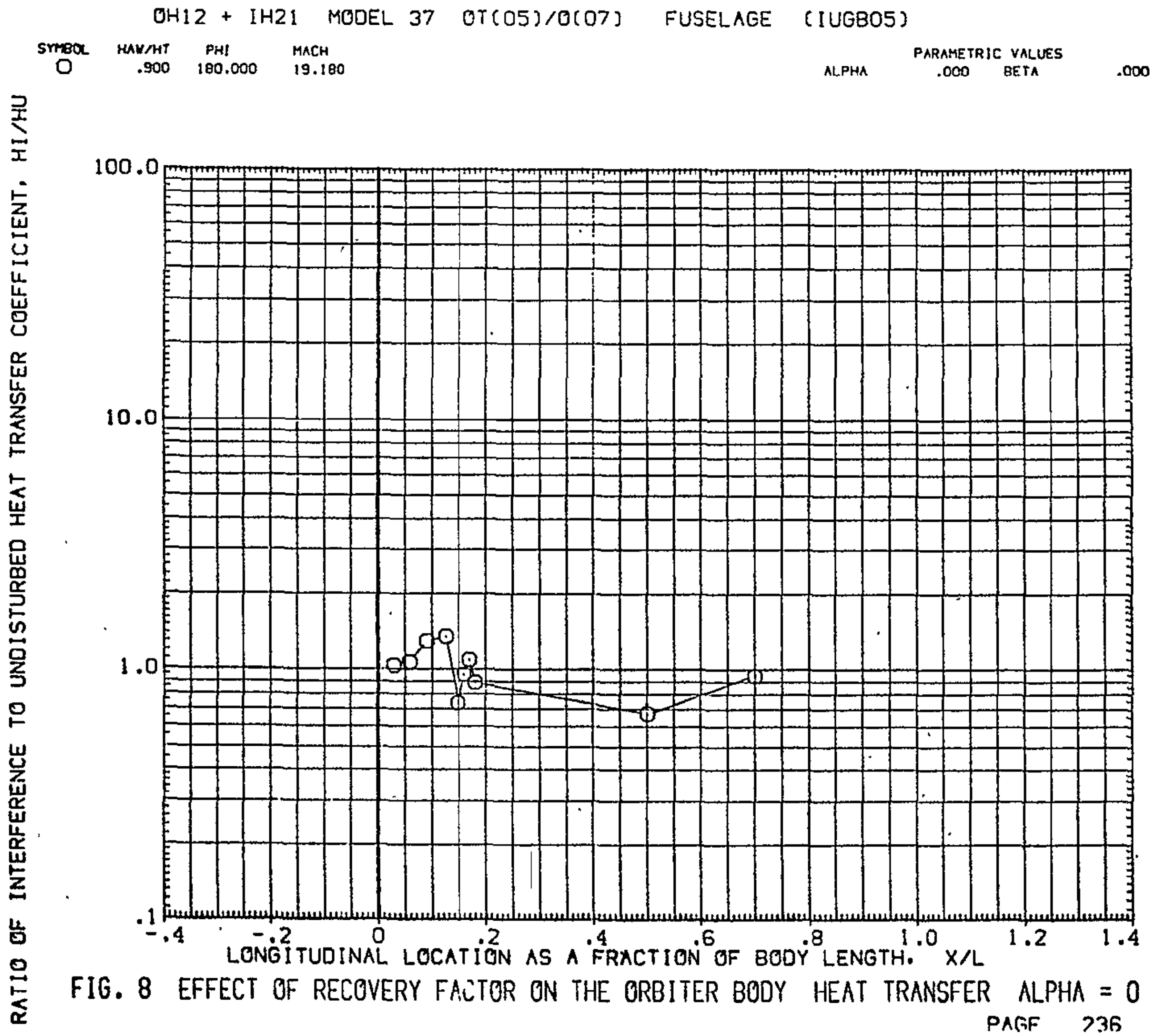

FIG. 8 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

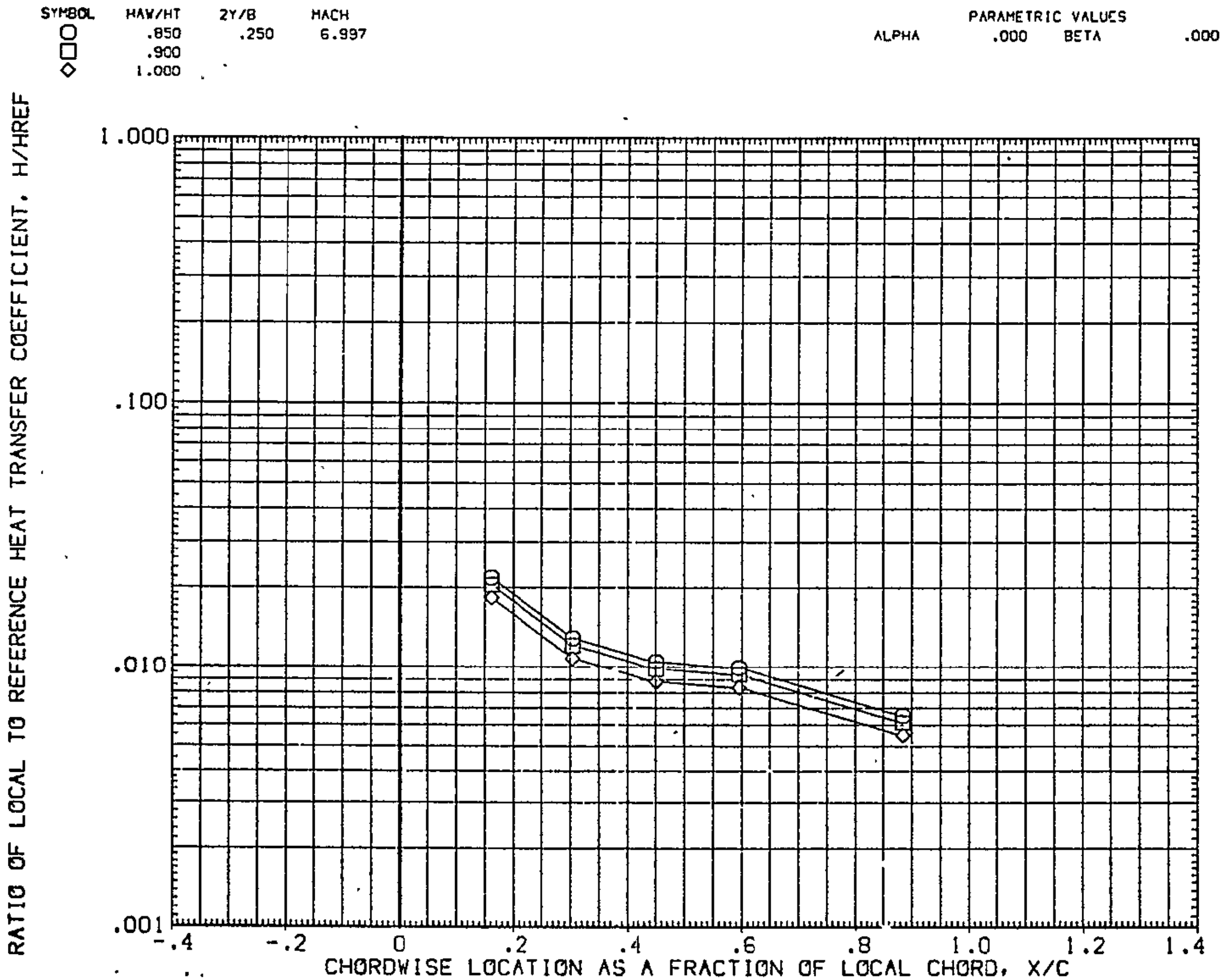

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

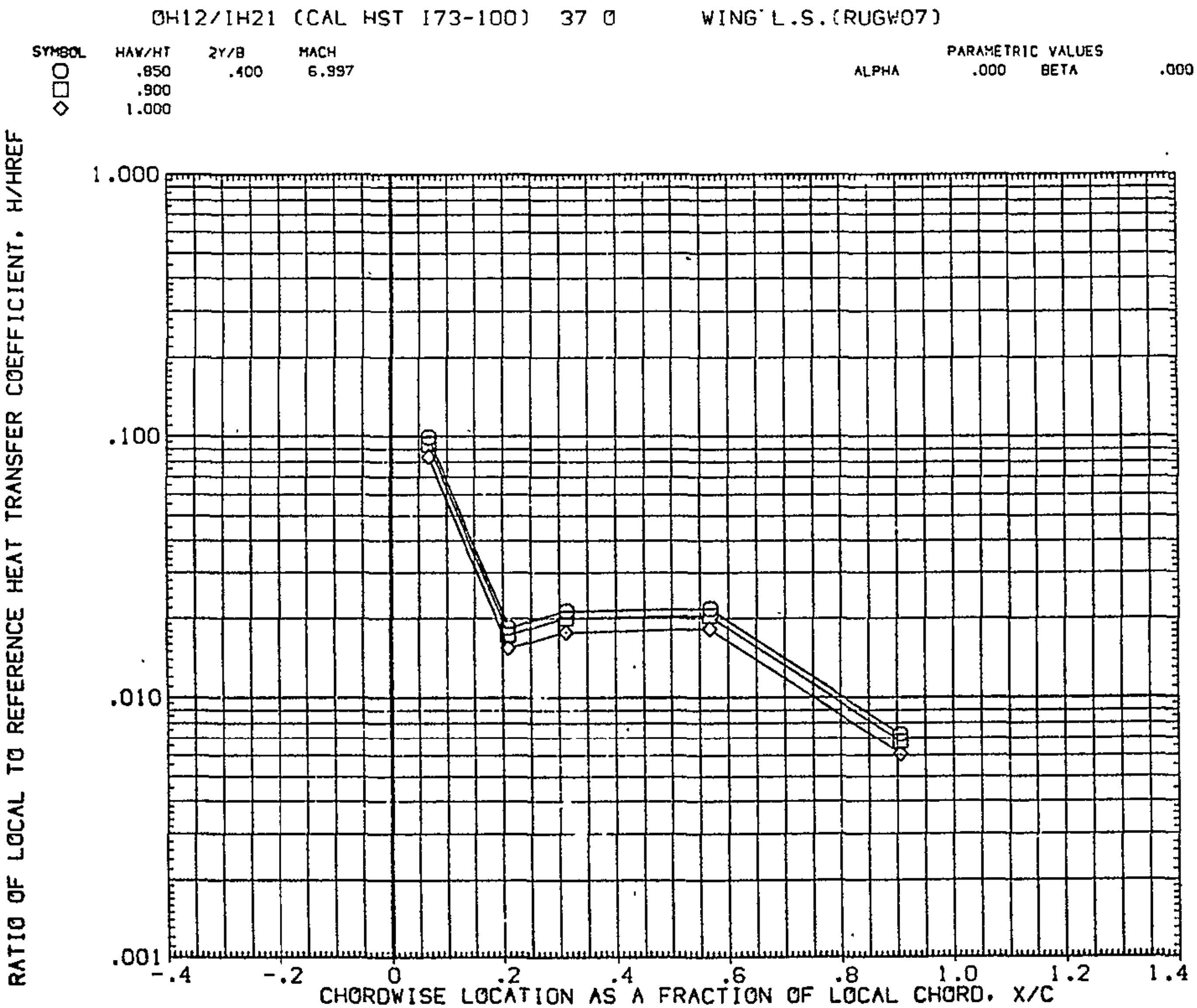

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER · ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37'0 WING L.S.(RUGW07)

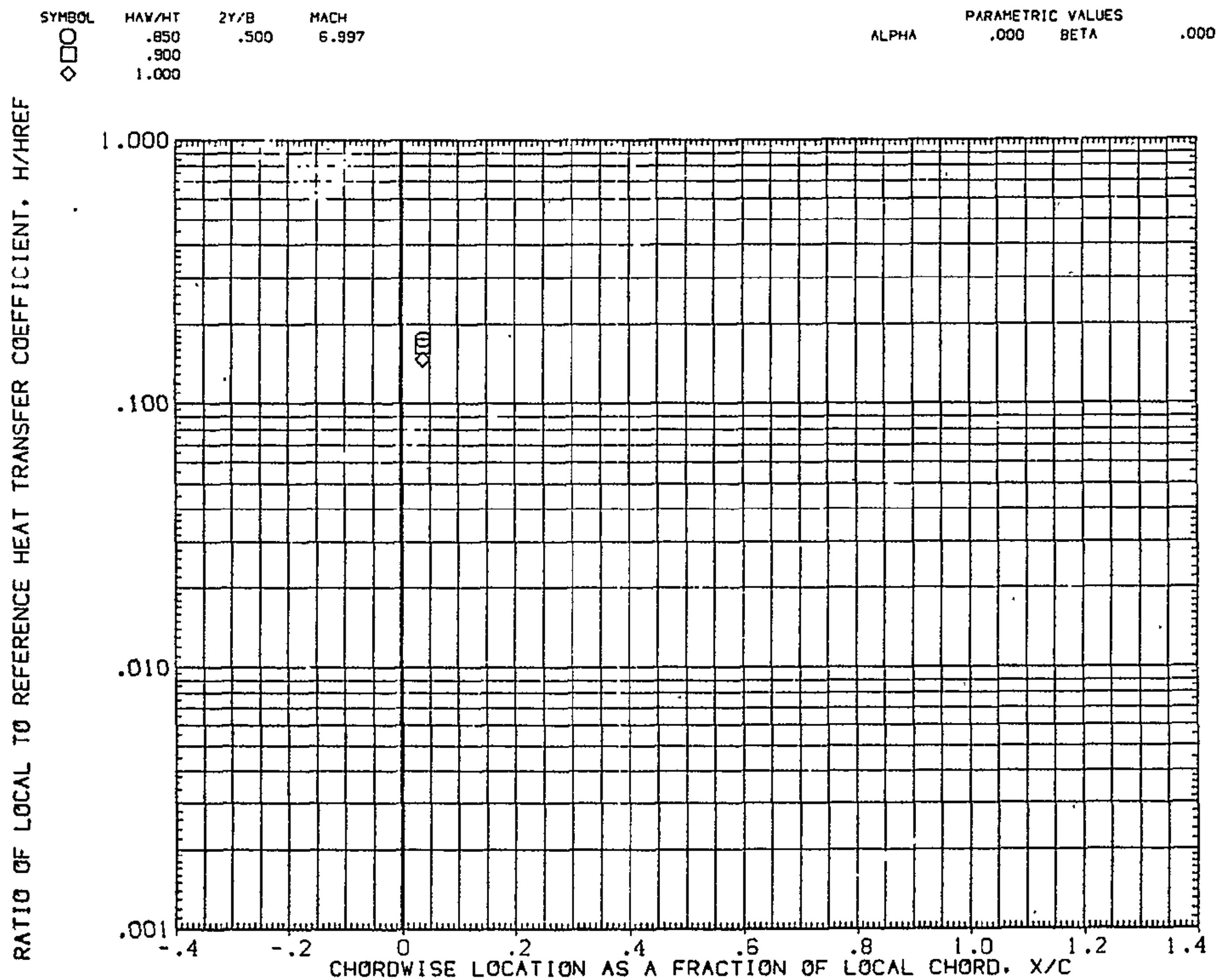

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

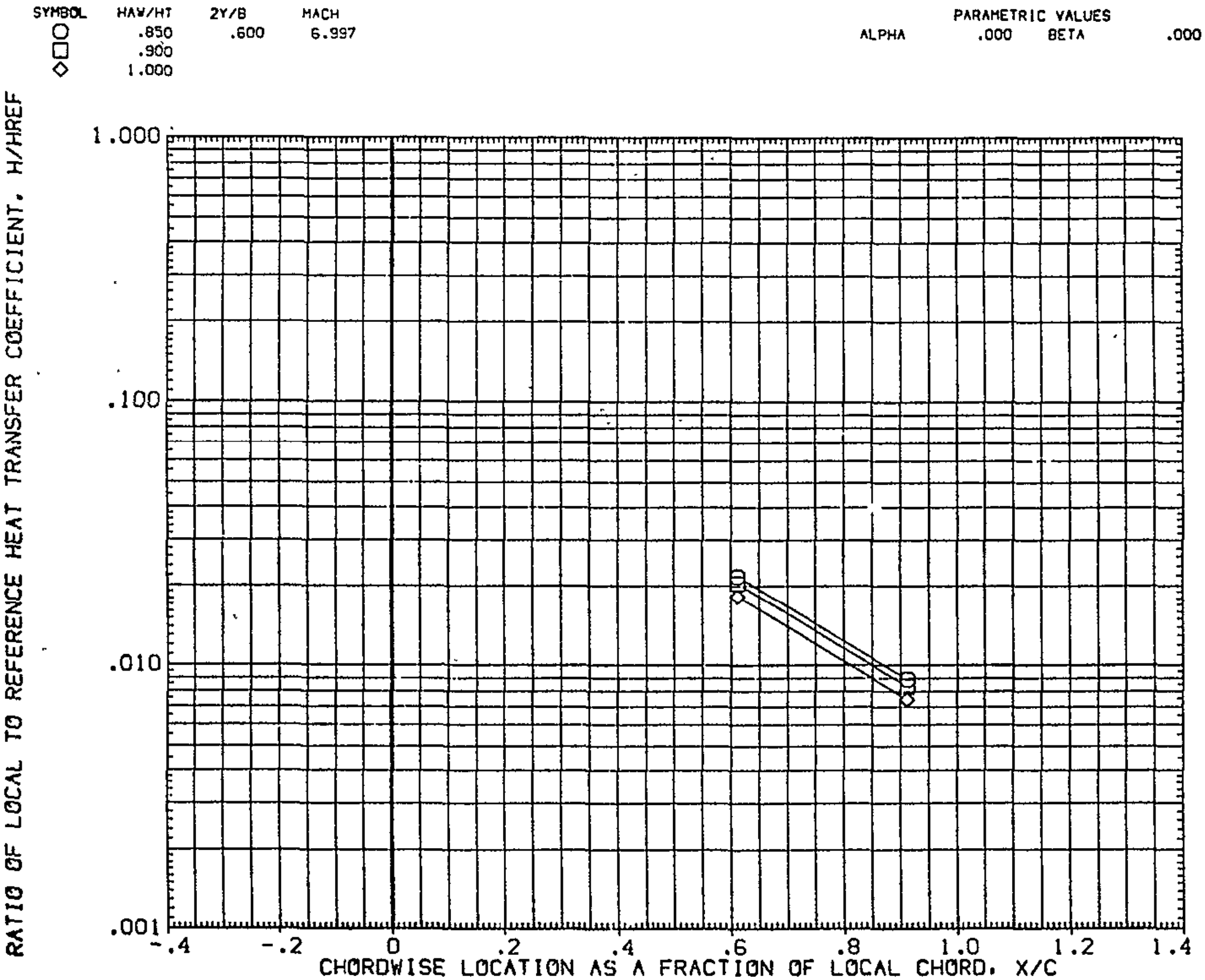

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

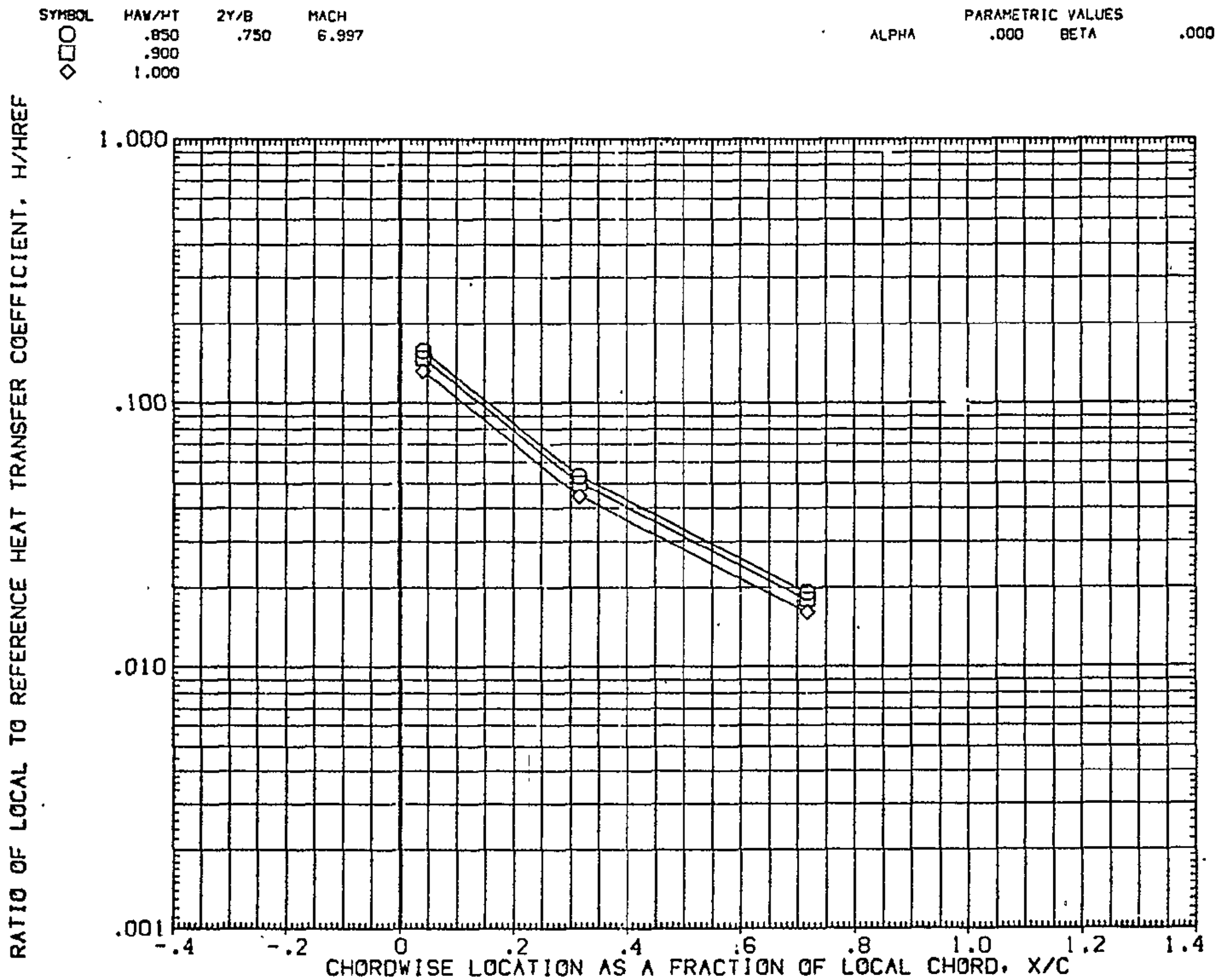

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

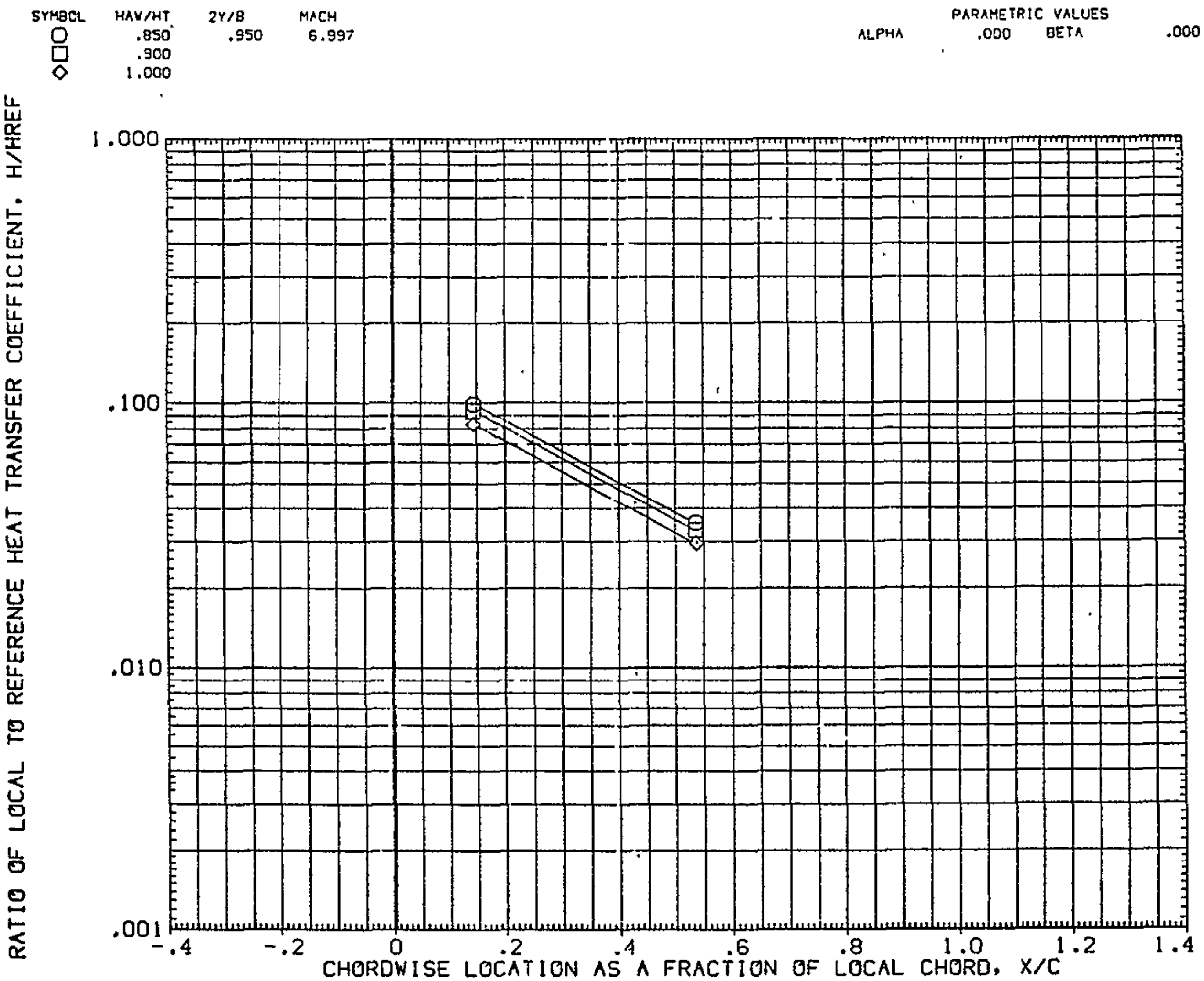

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

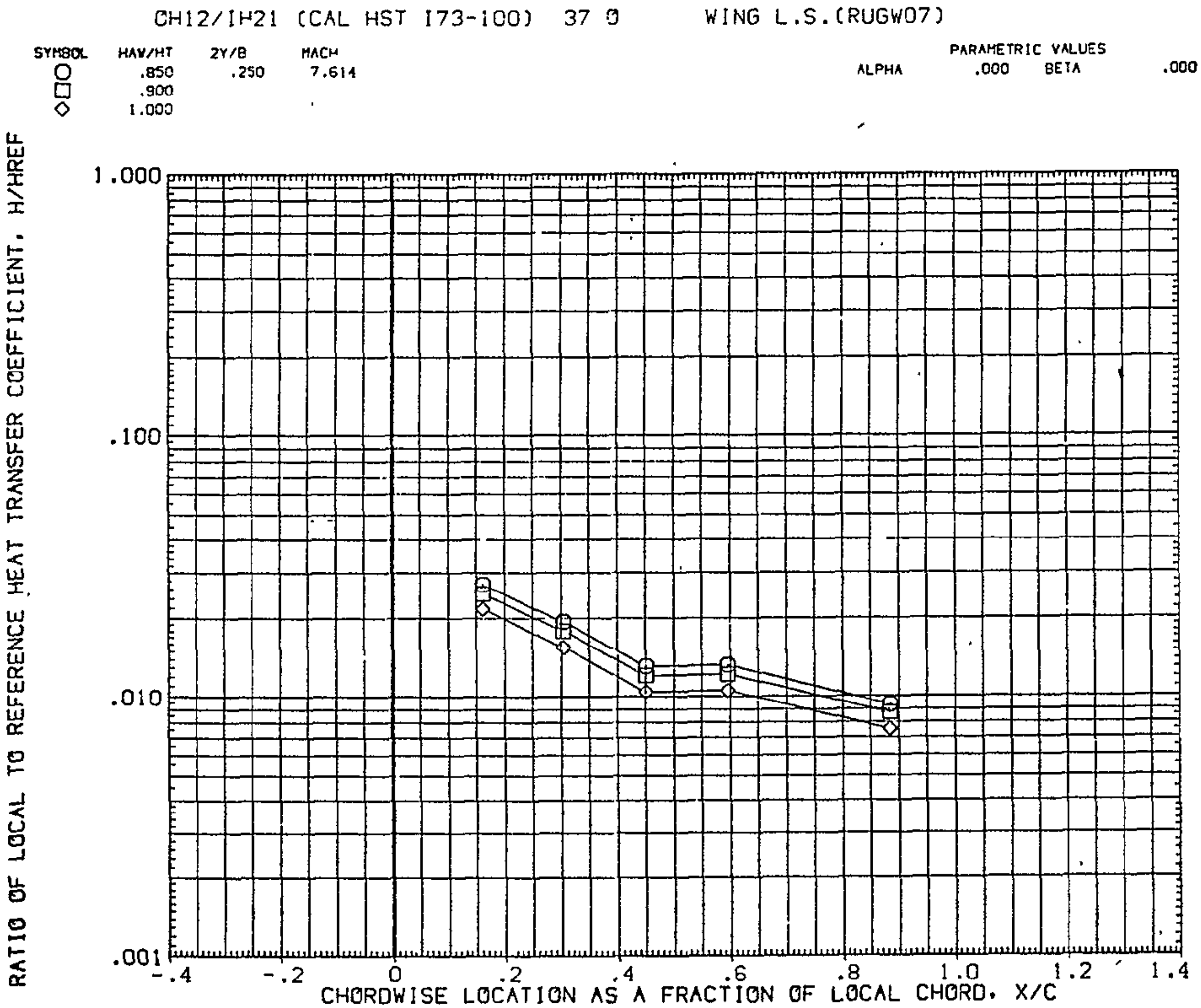

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

SYMBOL	HAW/HT	2Y/B	MACH
○	.850	.400	7.614
□	.900		
◇	1.000		

PARAMETRIC VALUES

ALPHA .000 BETA .000

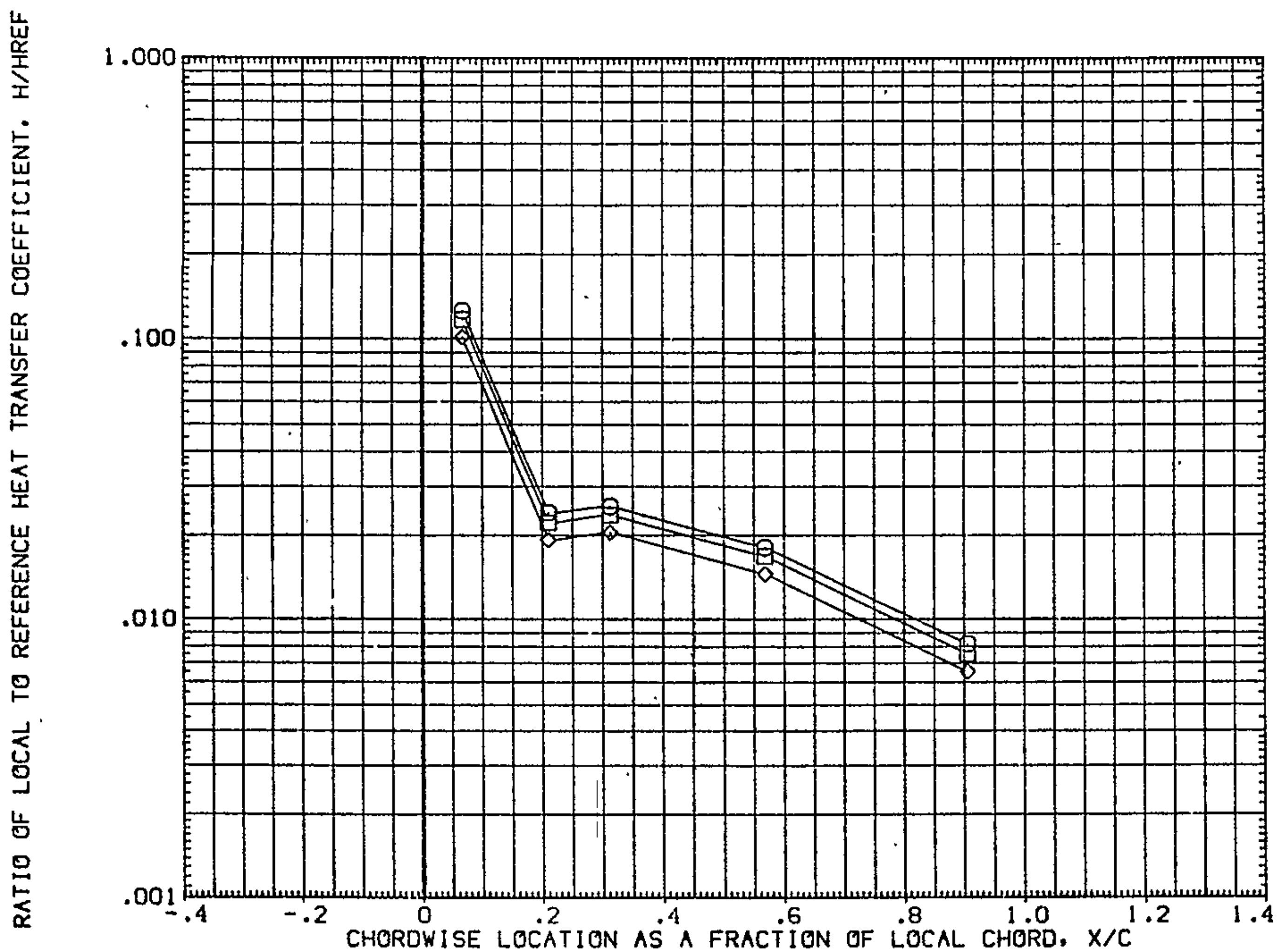

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

SYMBOL	HAW/HT	2Y/B	MACH
○	.850	.500	7.614
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA .000 BETA .000

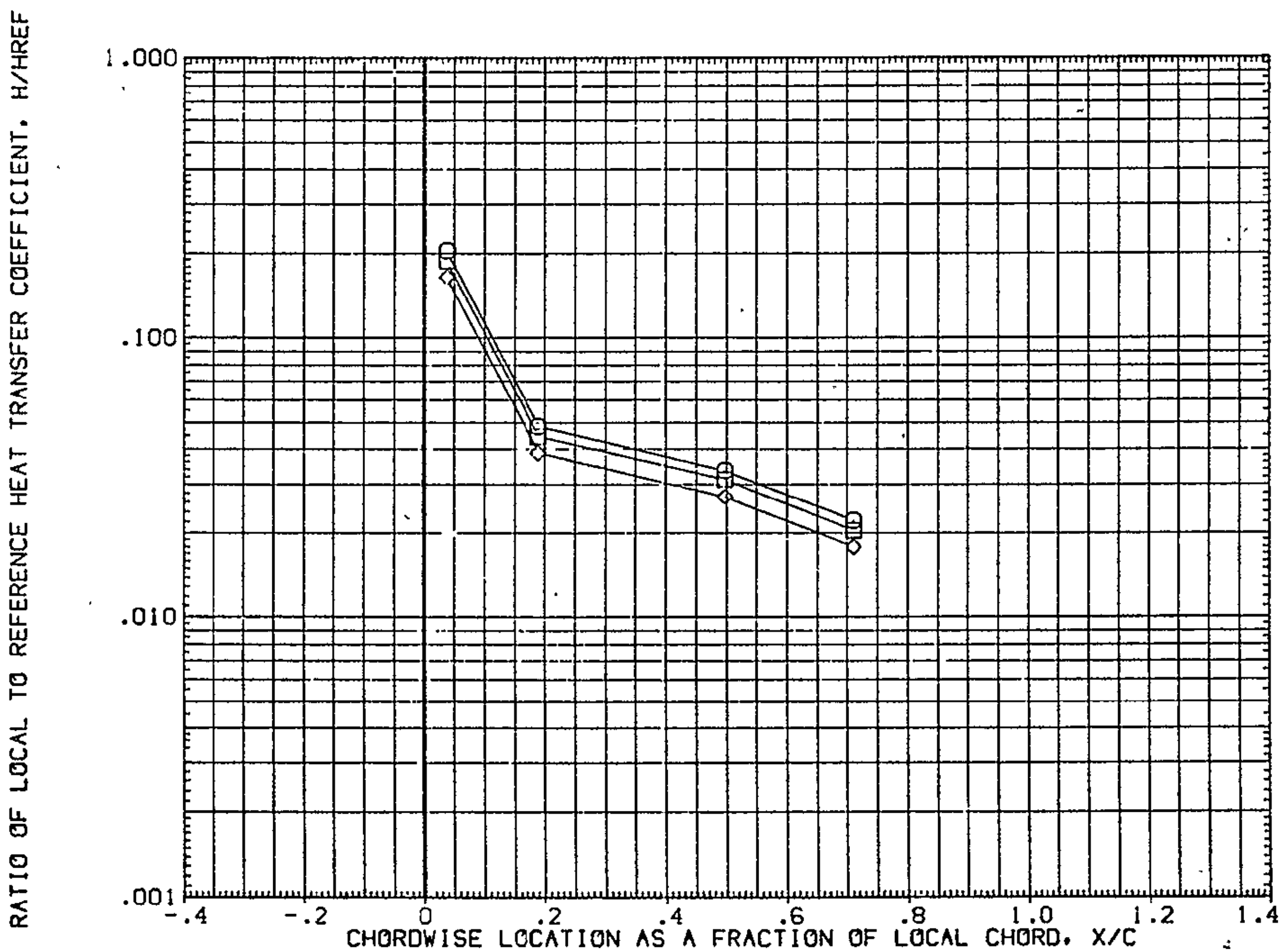

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

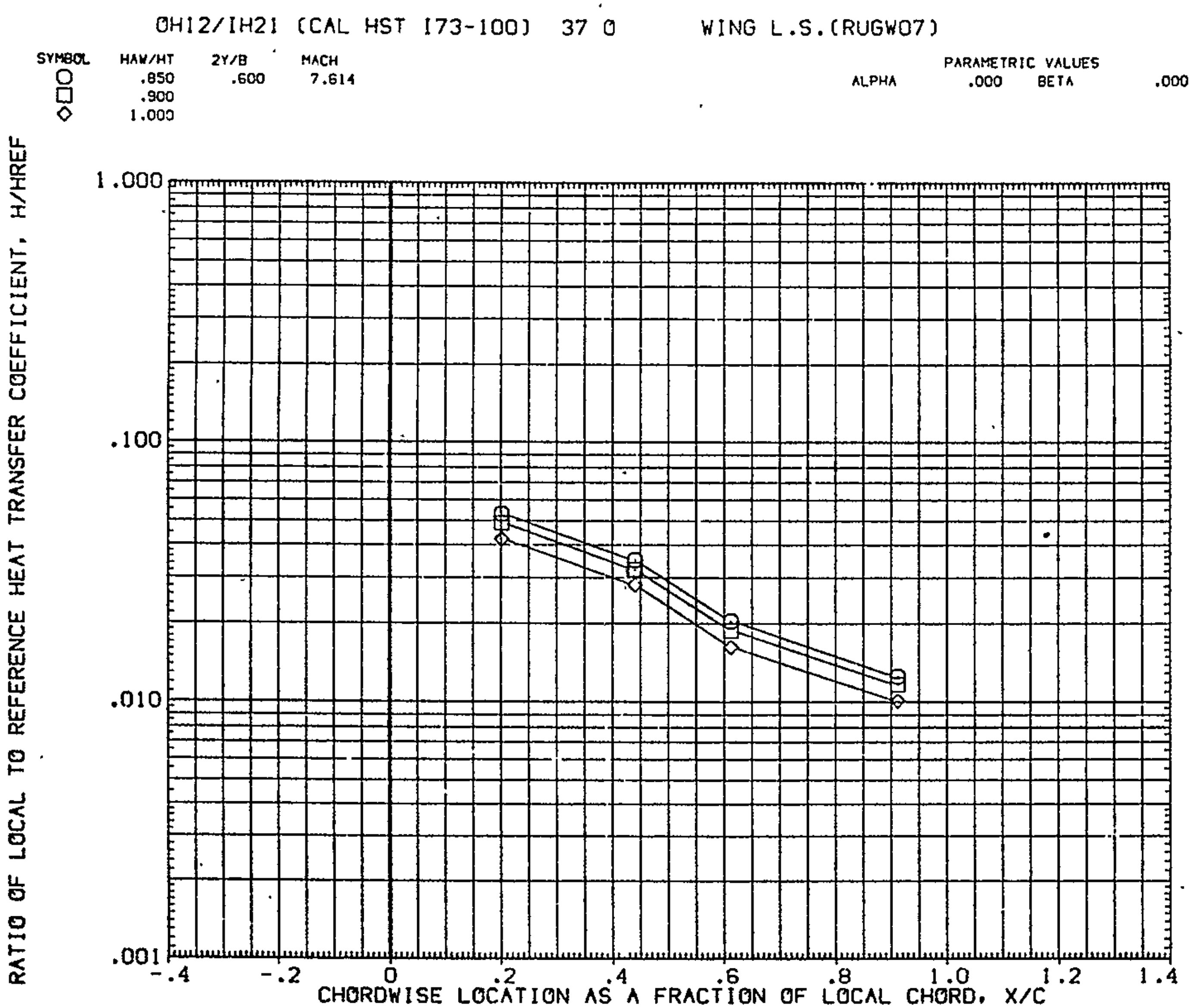

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

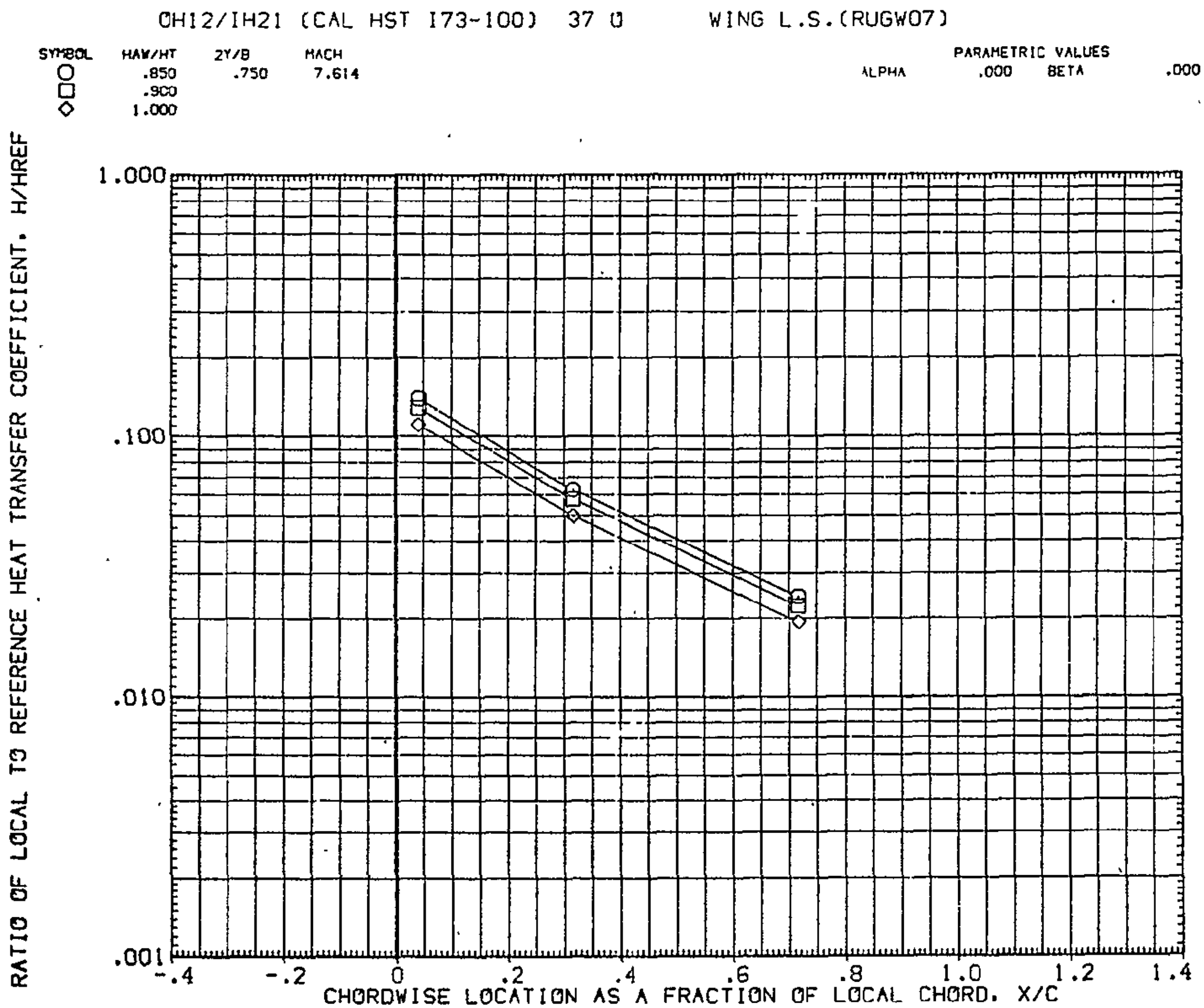

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

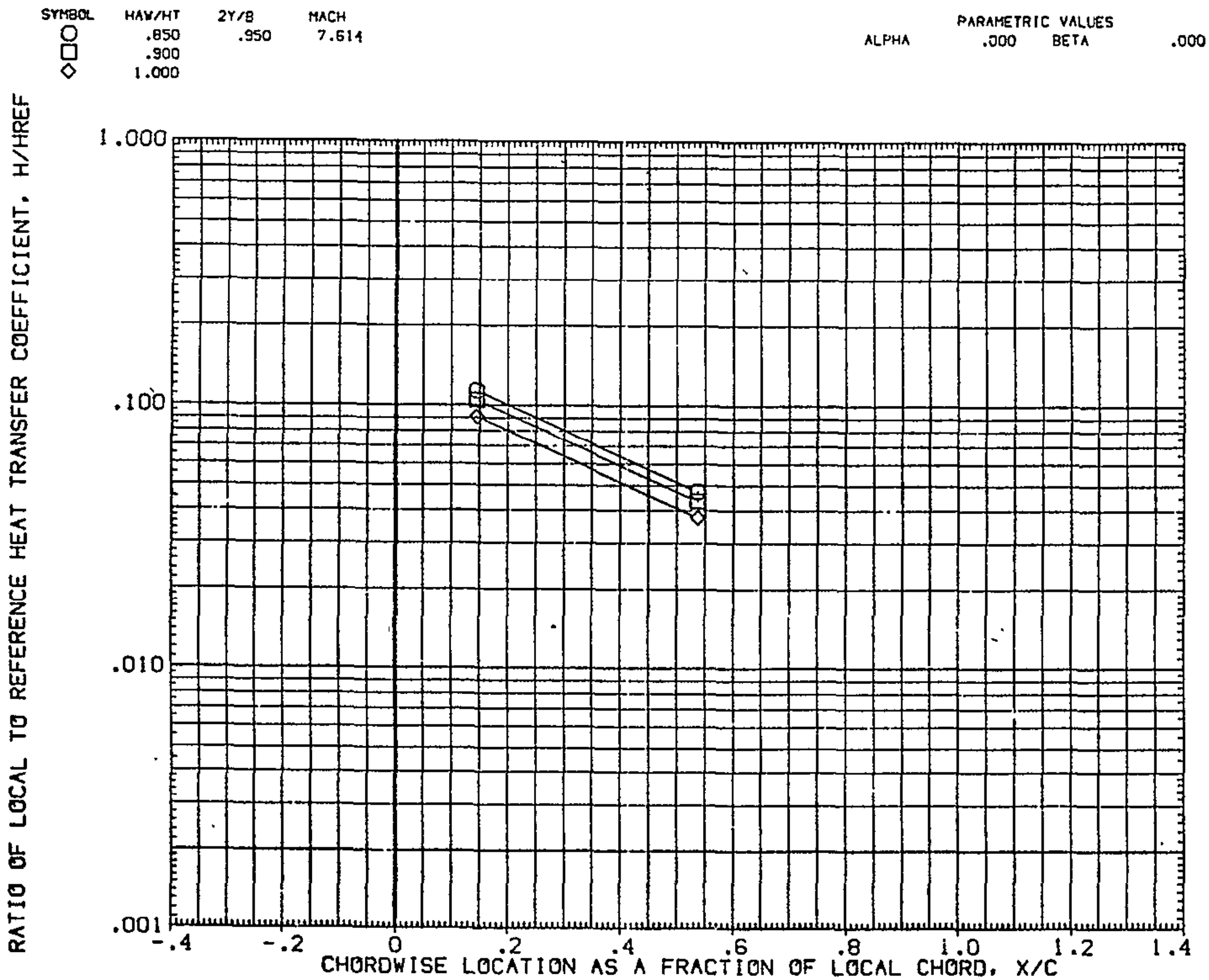

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

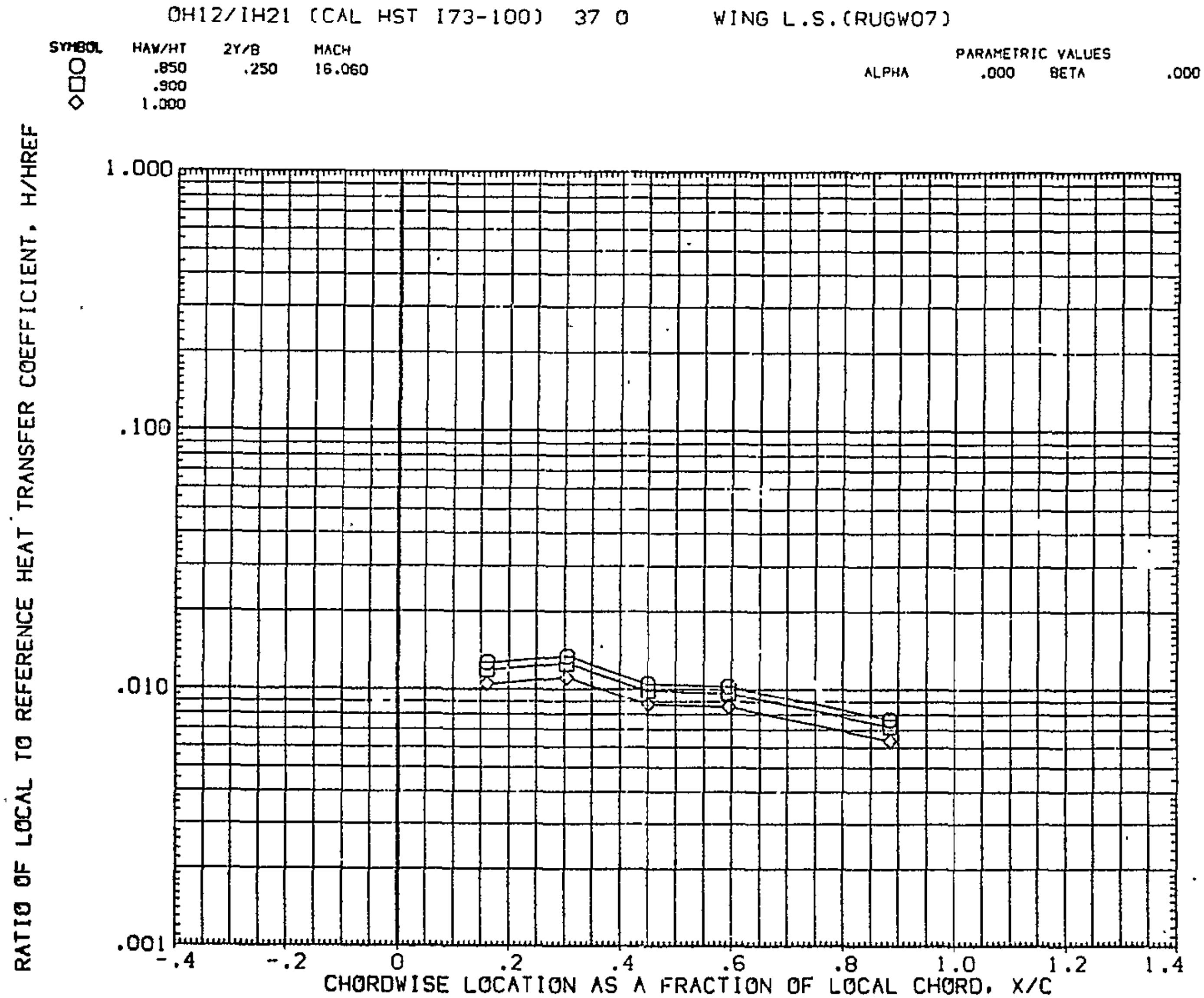

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

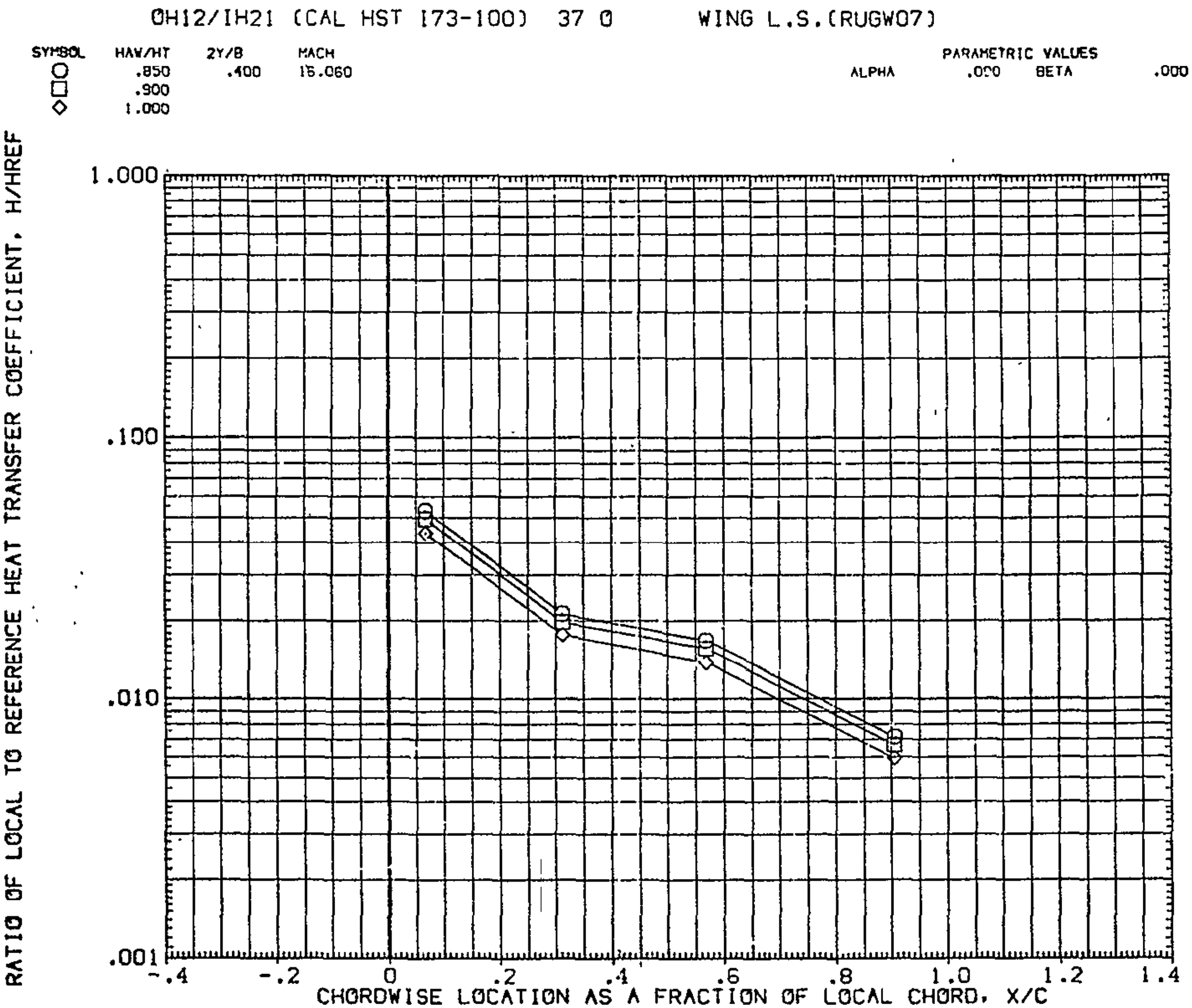

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

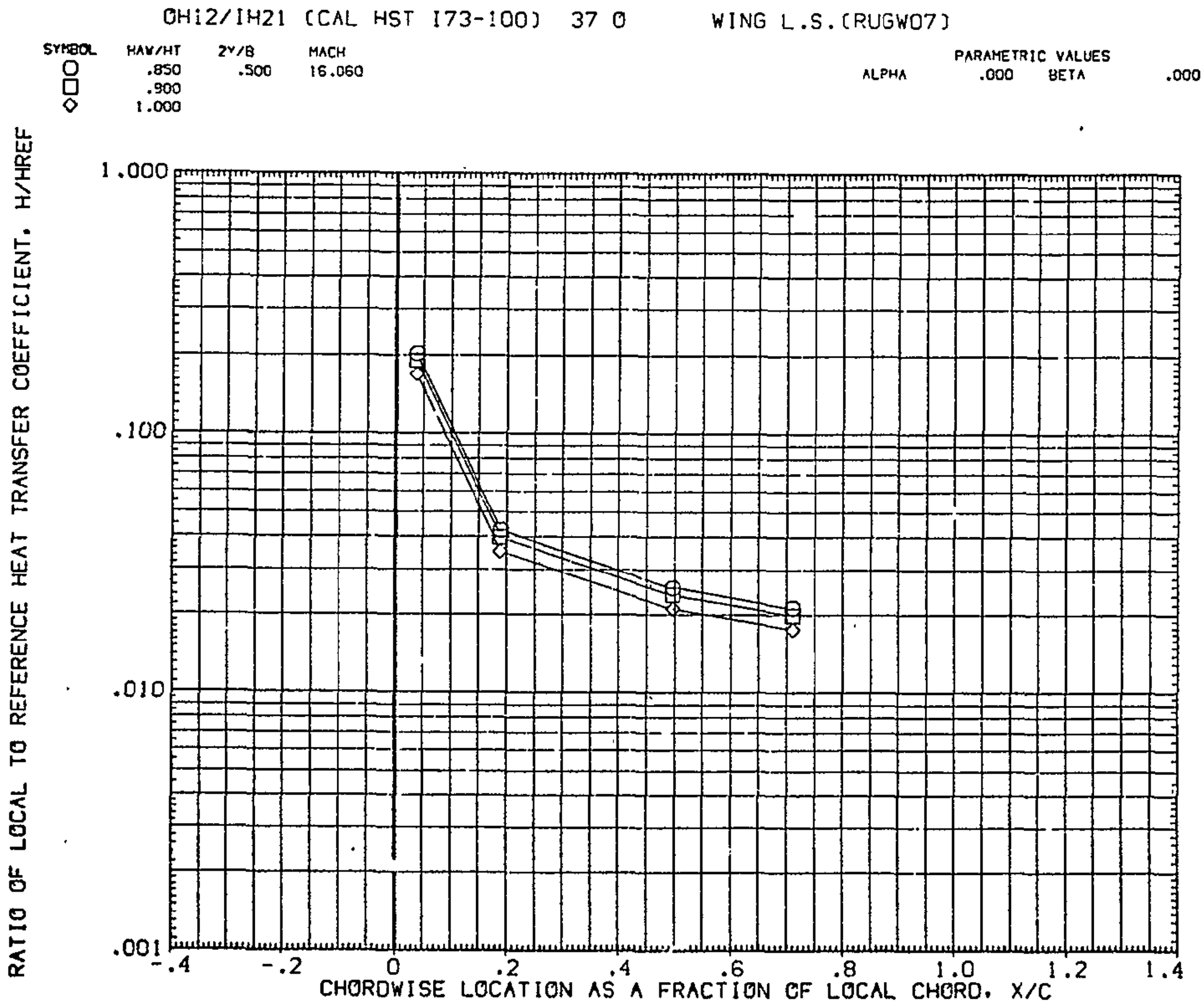

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

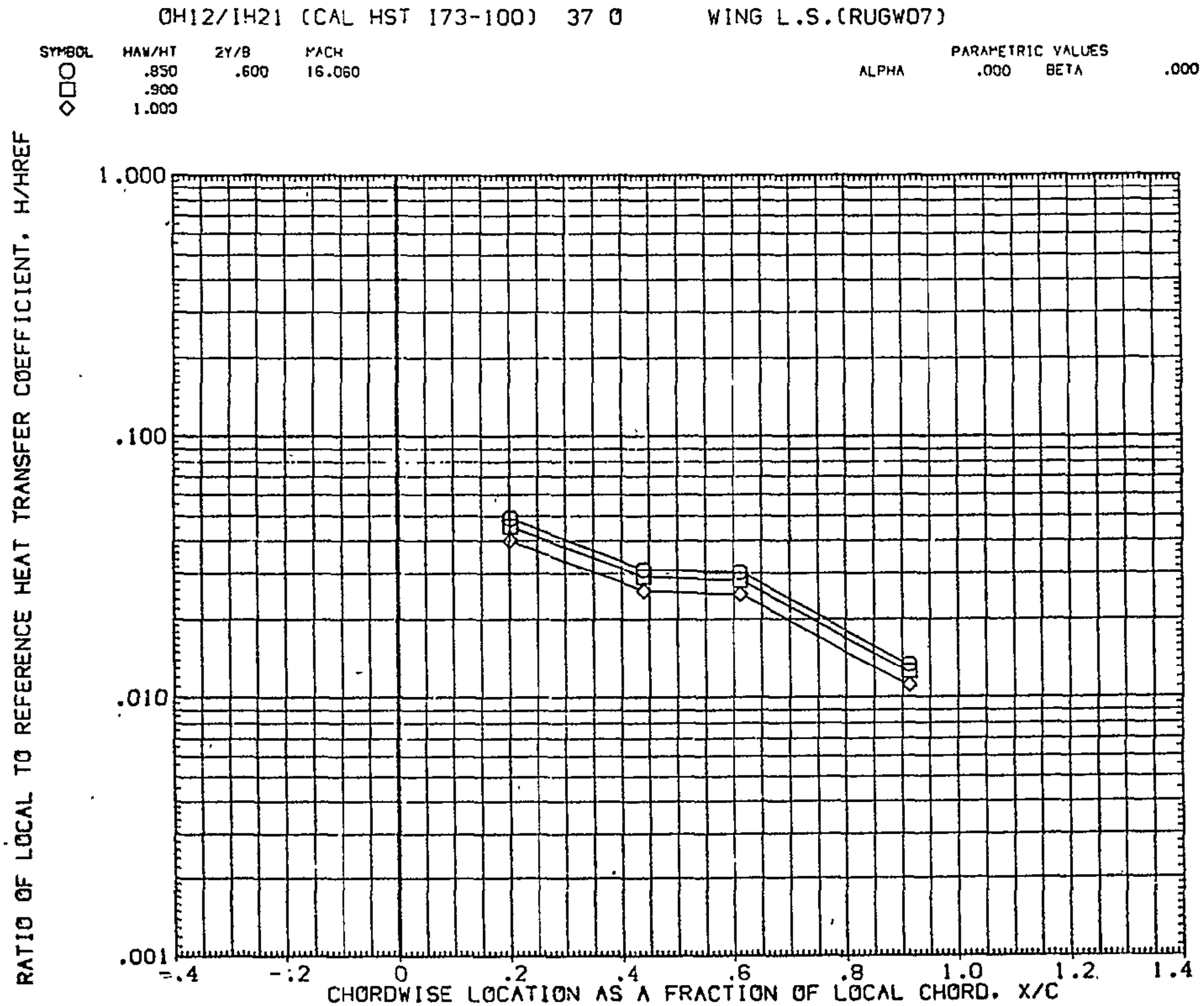

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

0H12/1H21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

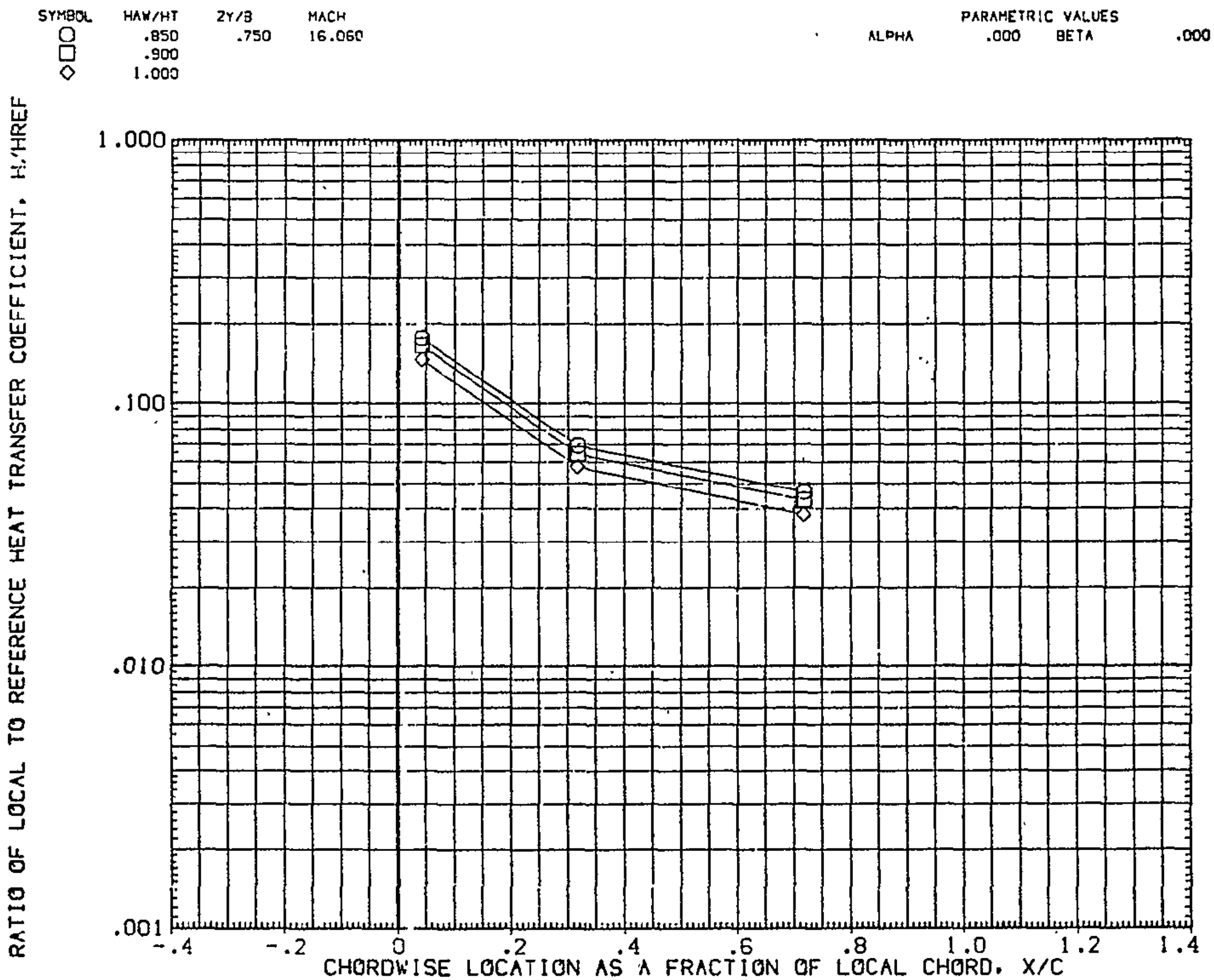

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

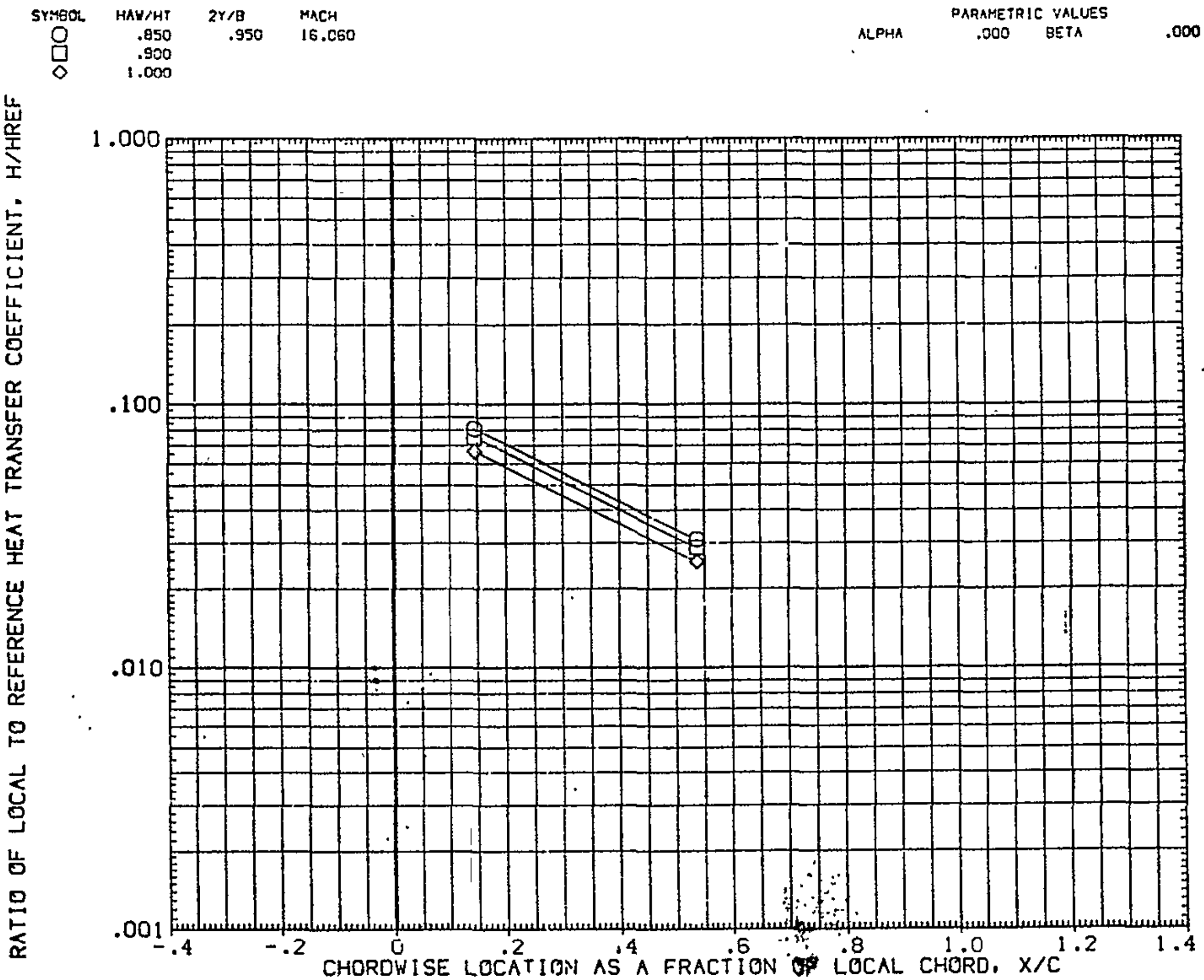

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

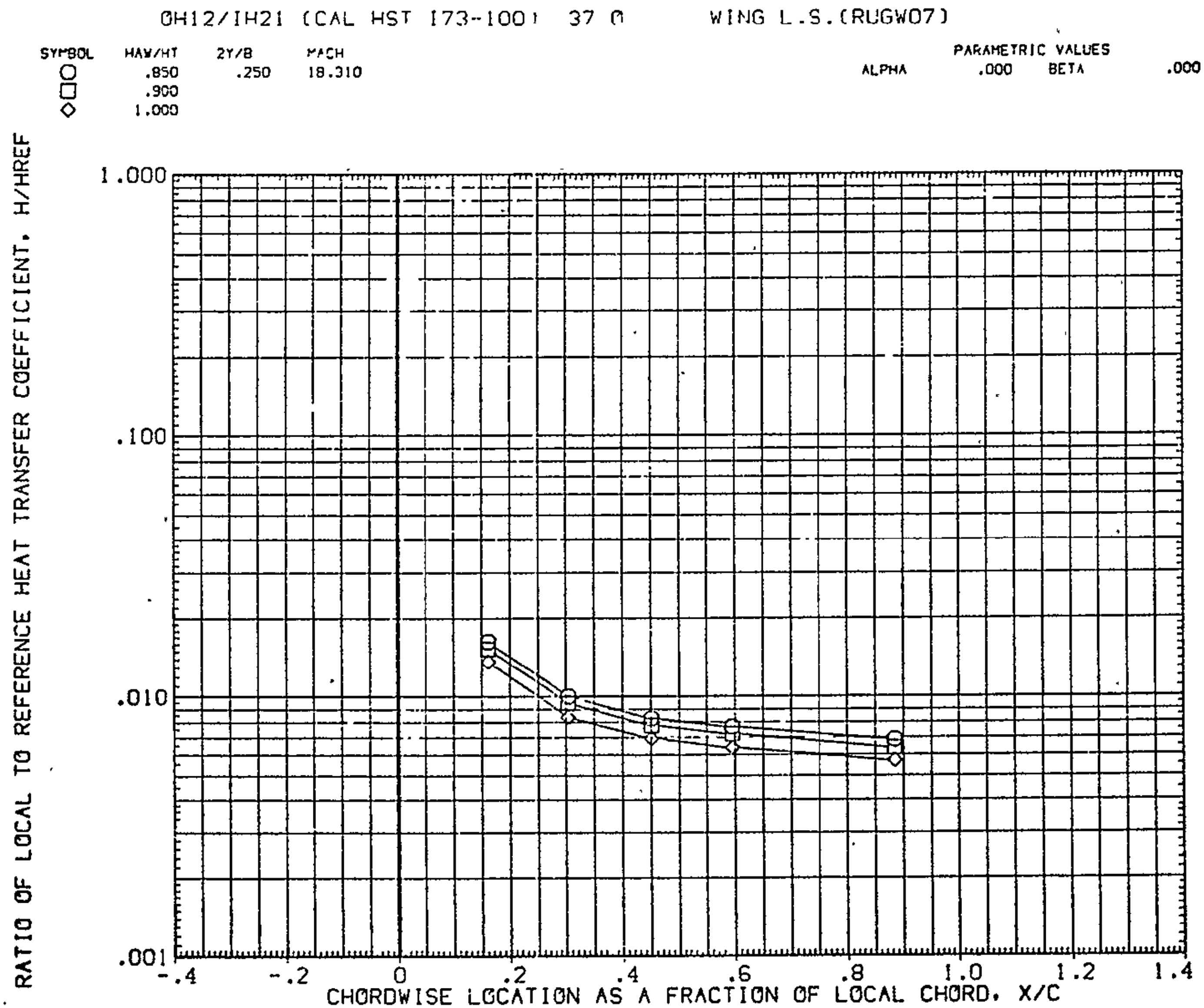

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

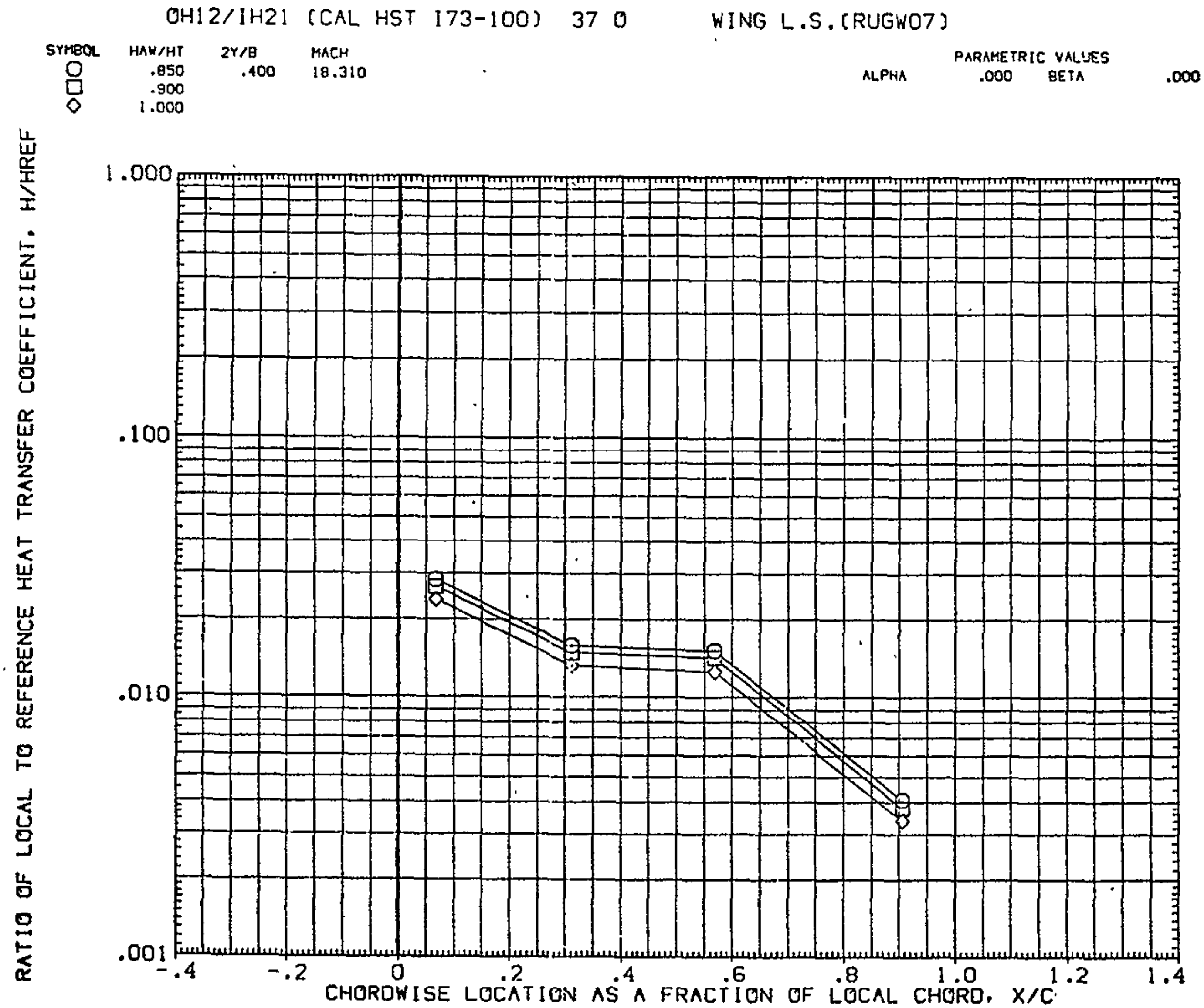

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

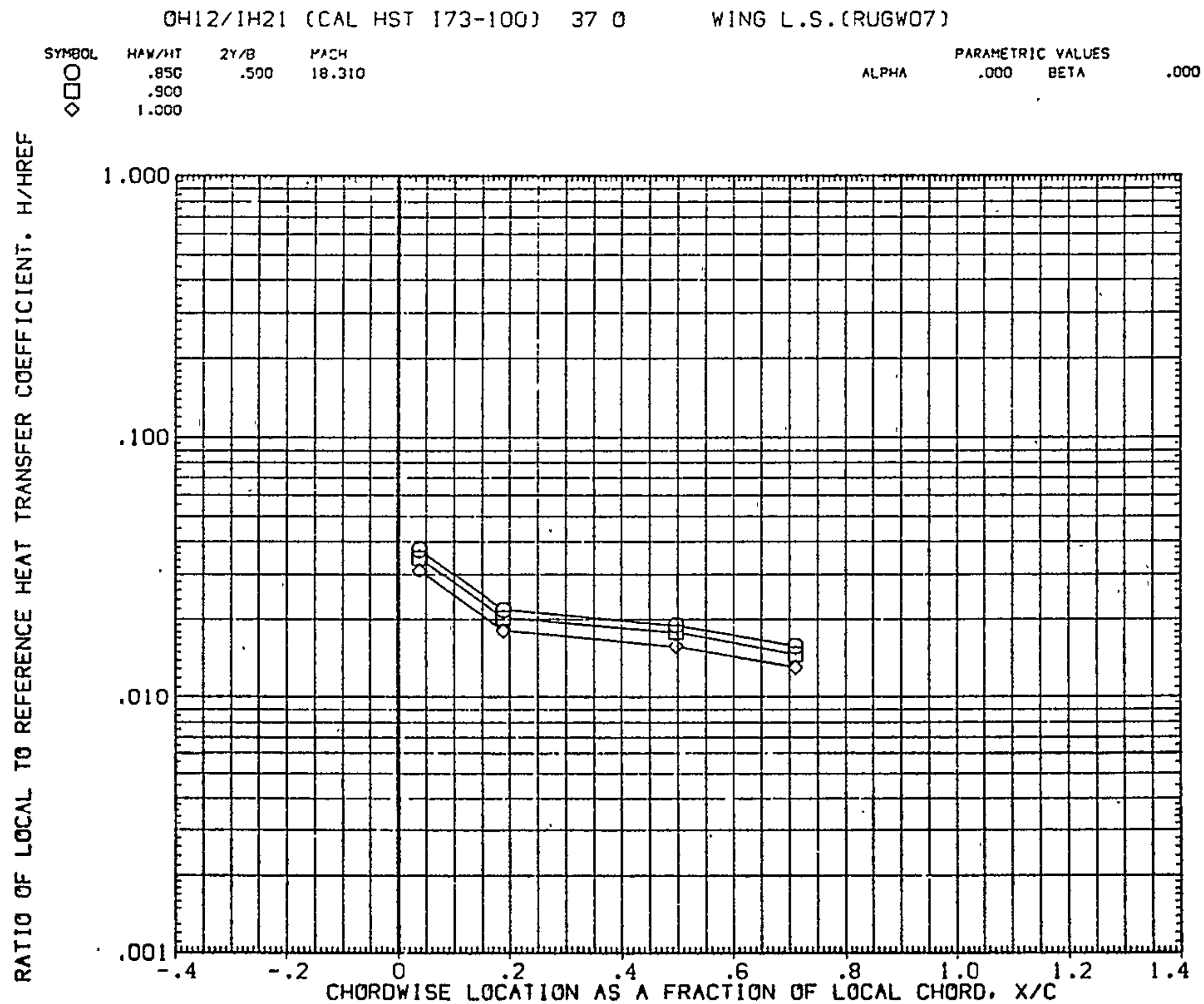

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

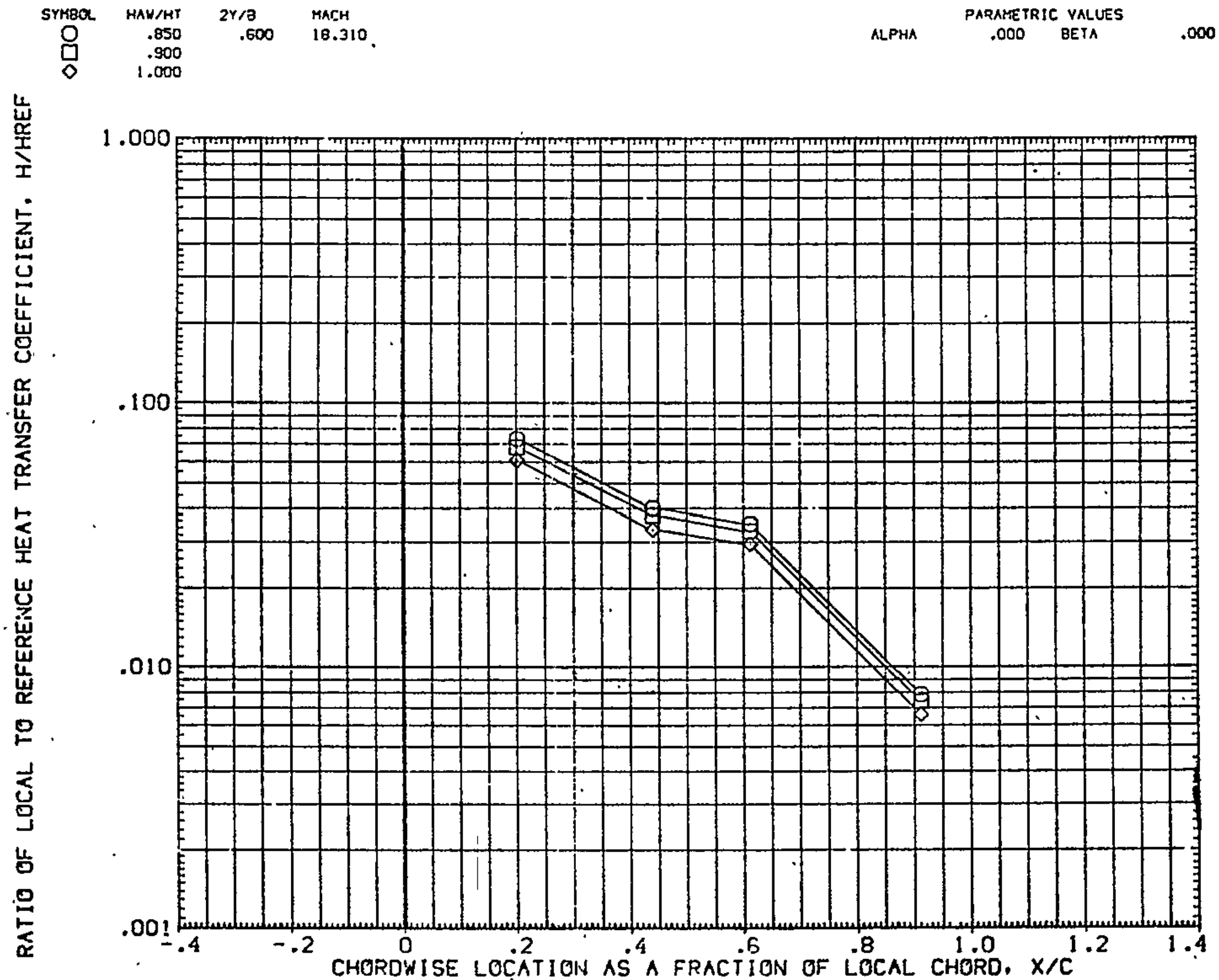

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW07)

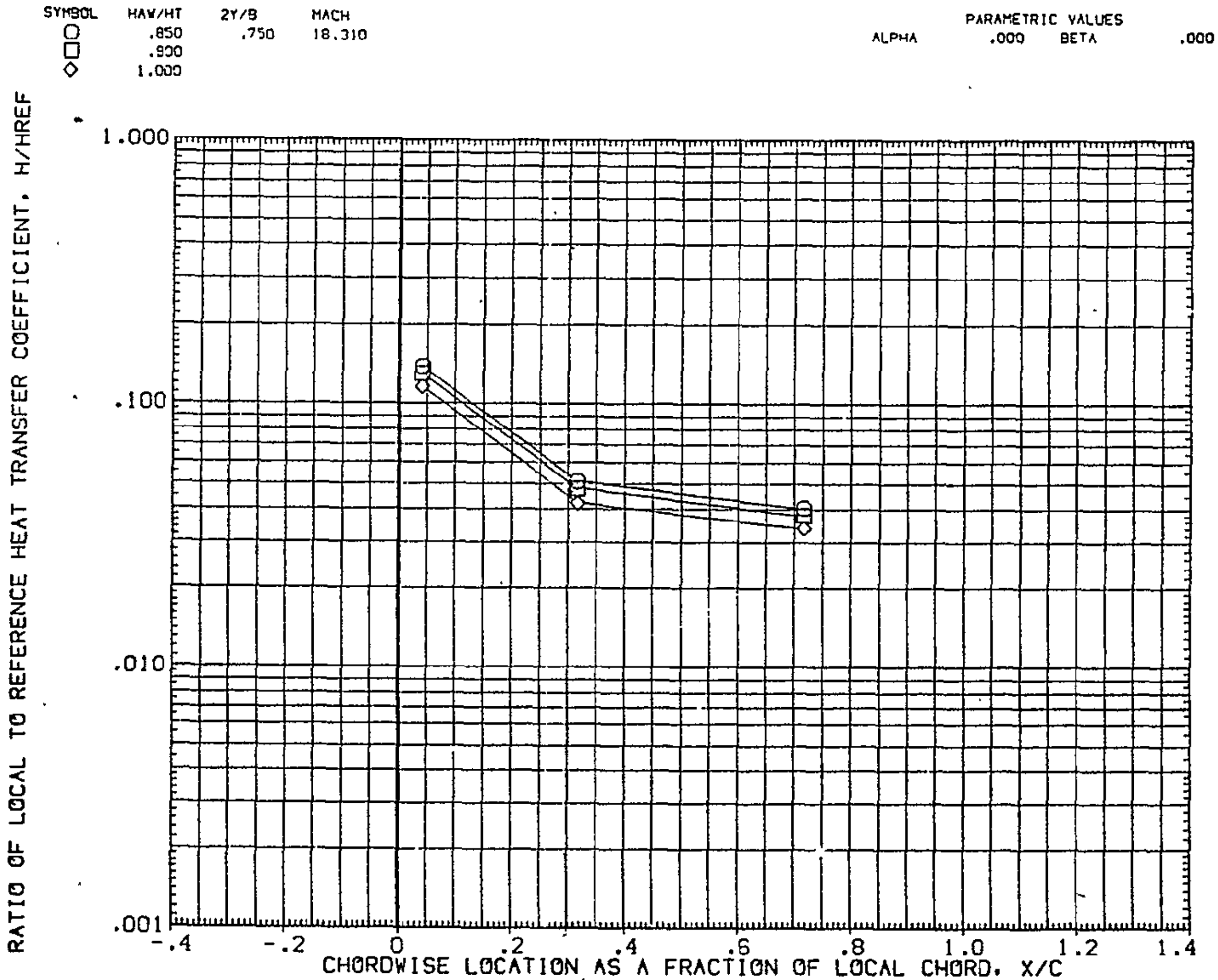

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

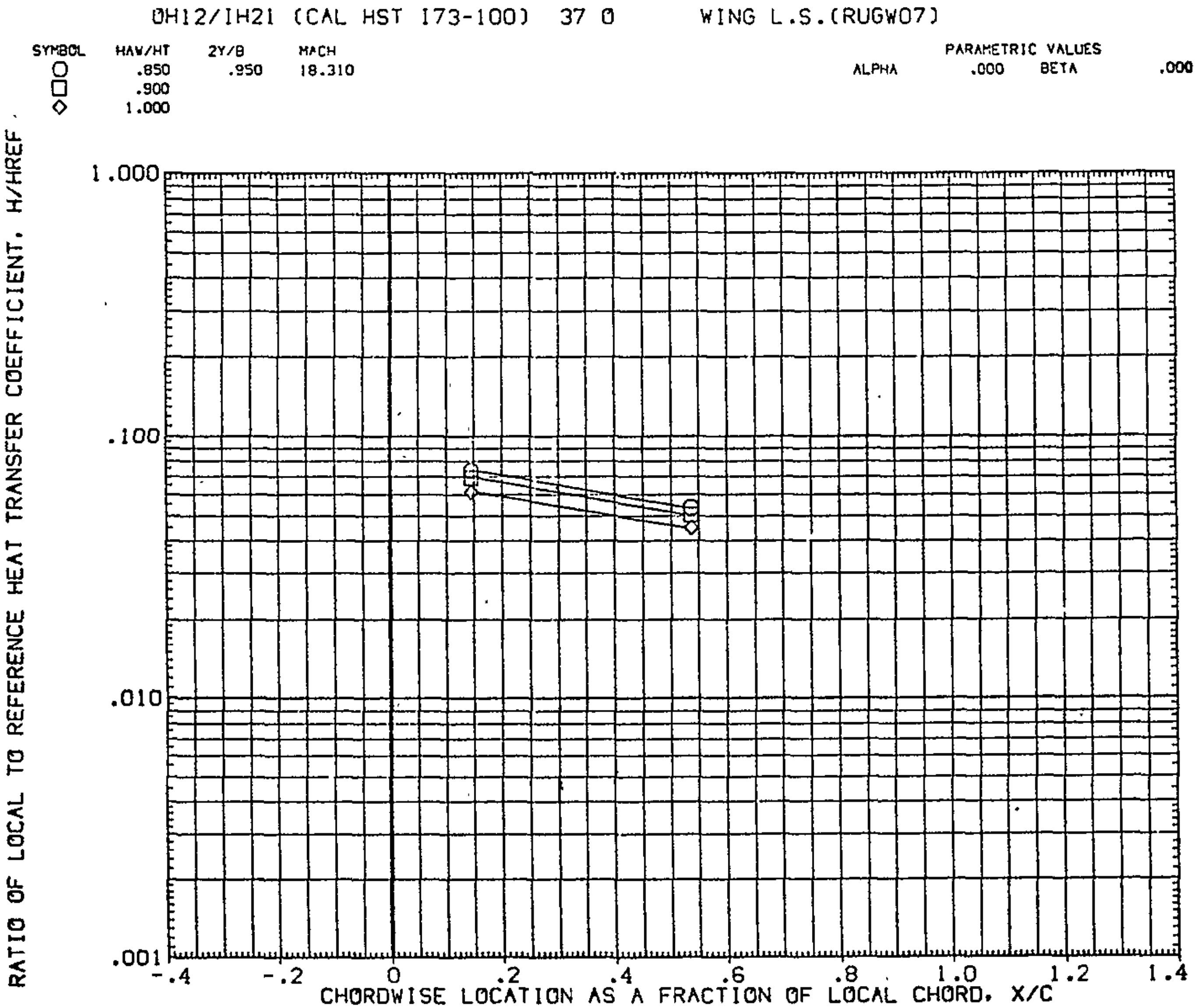

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

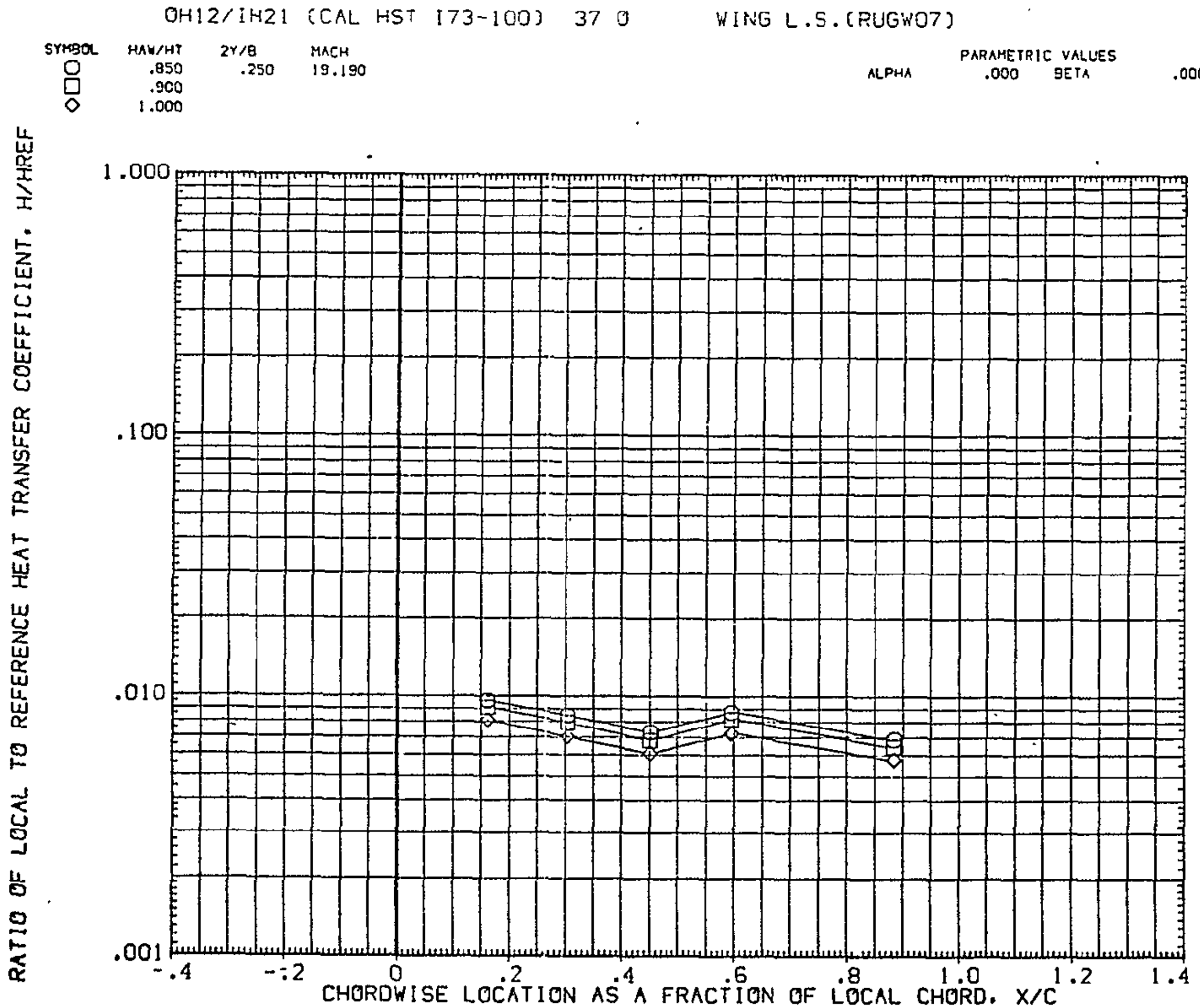

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

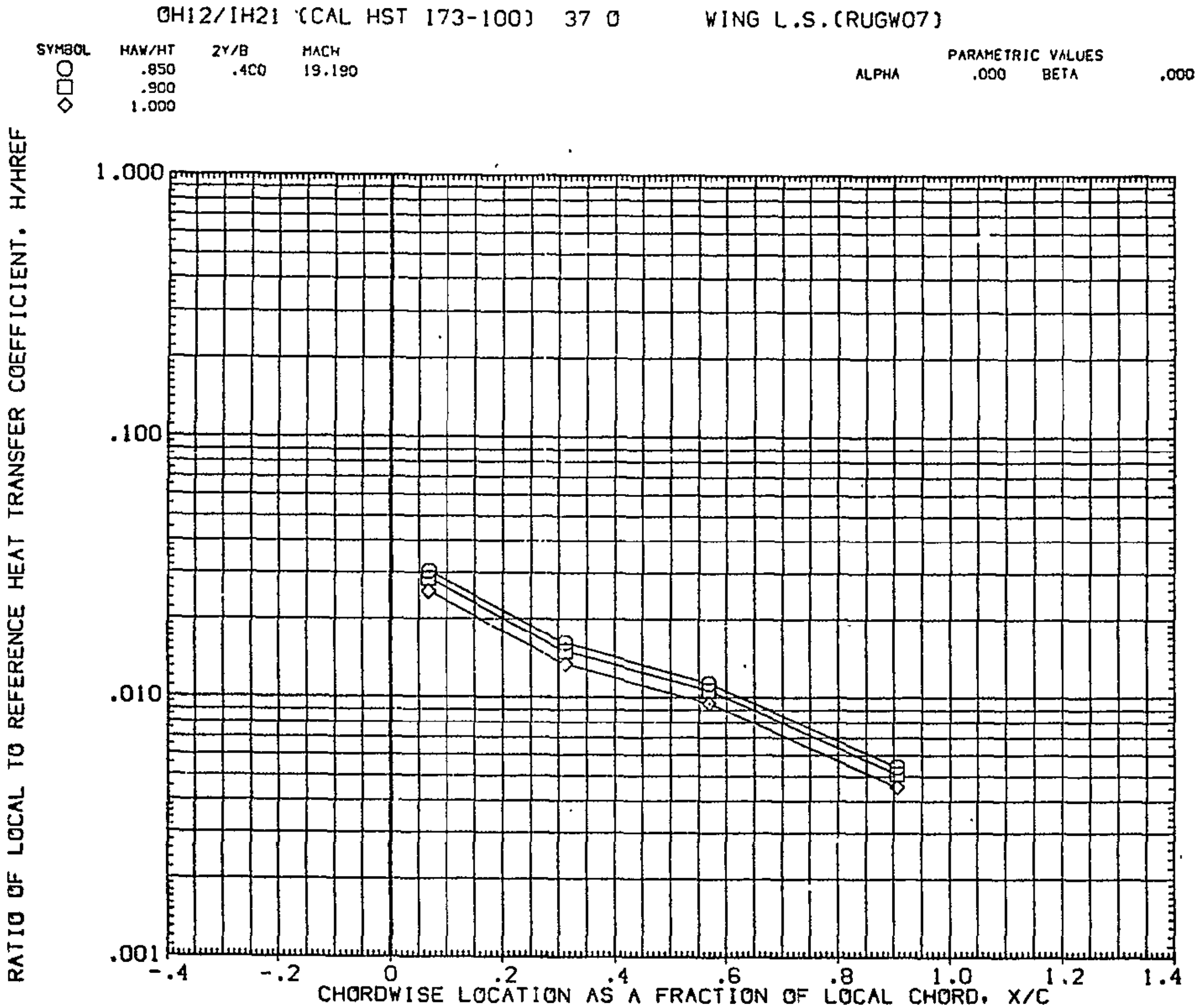

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 WING L.S.(RUGW07)

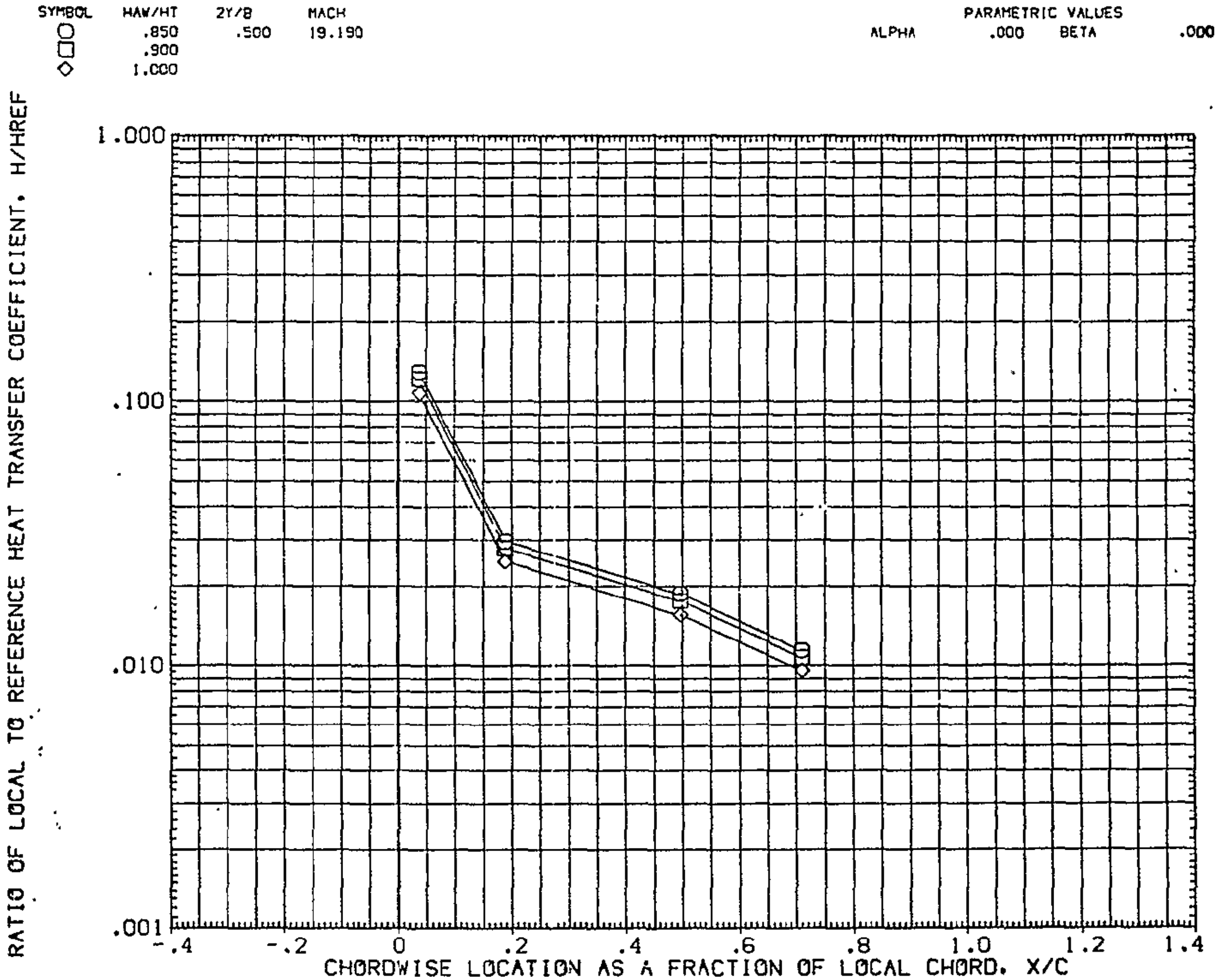

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

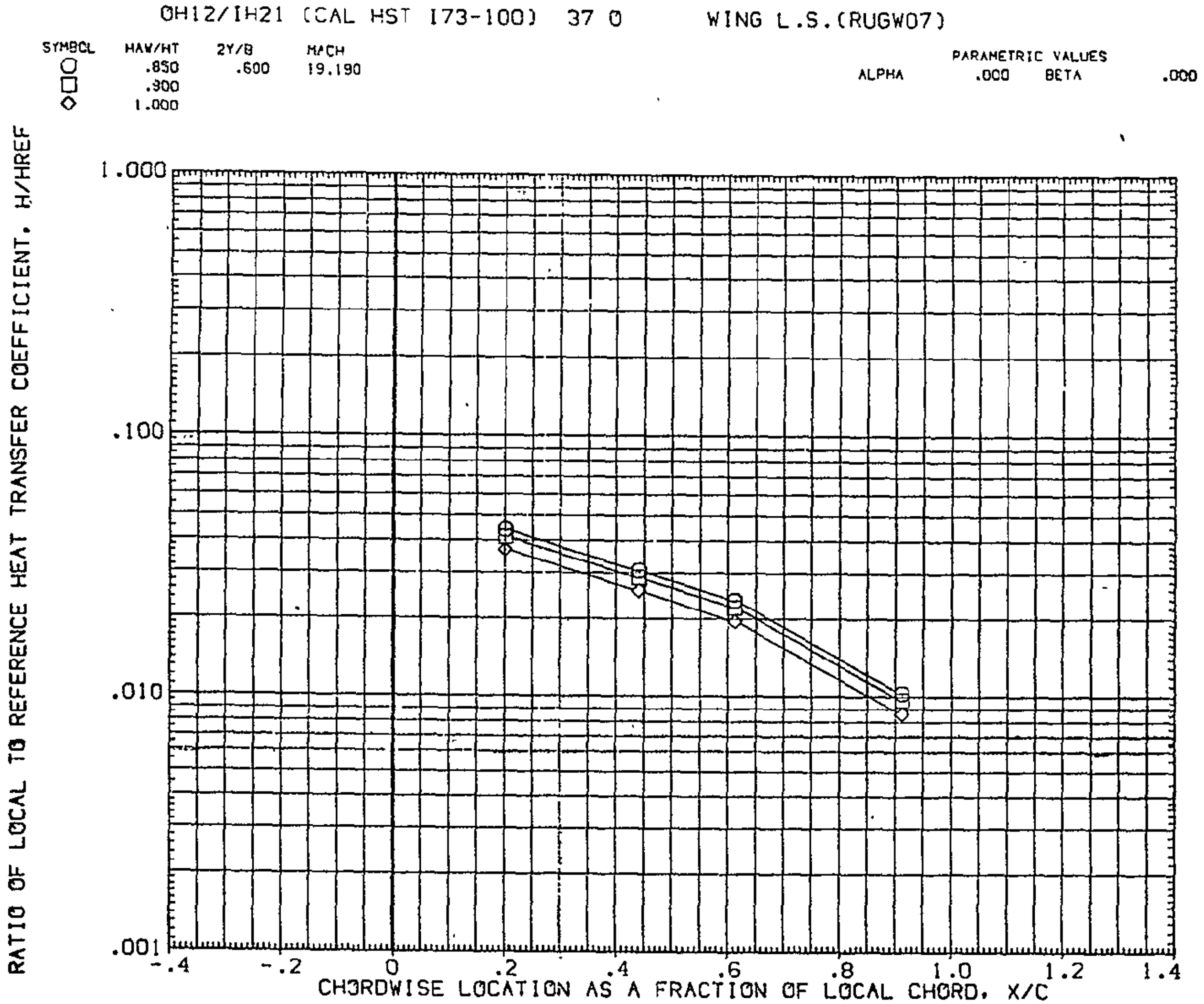

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

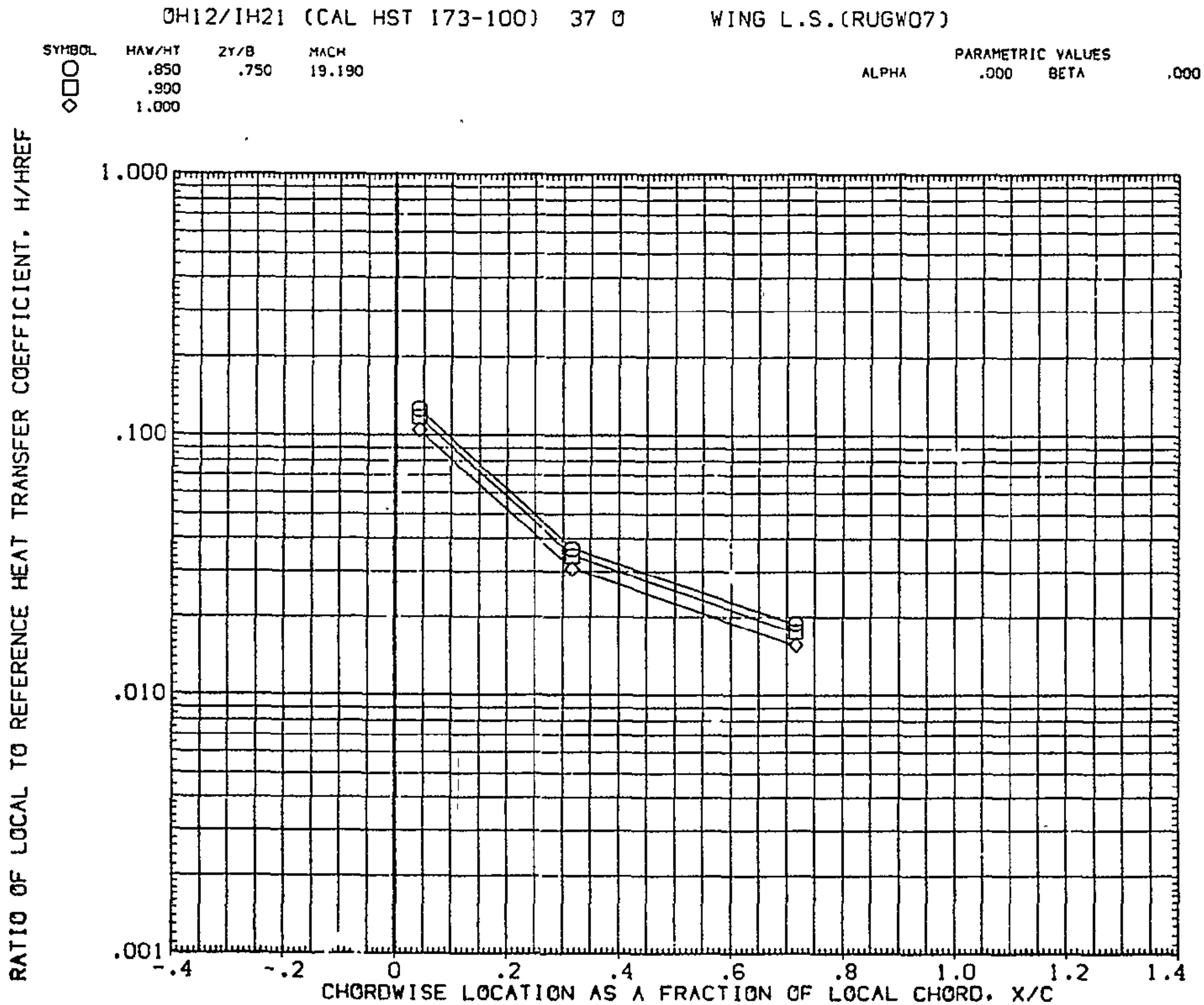

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

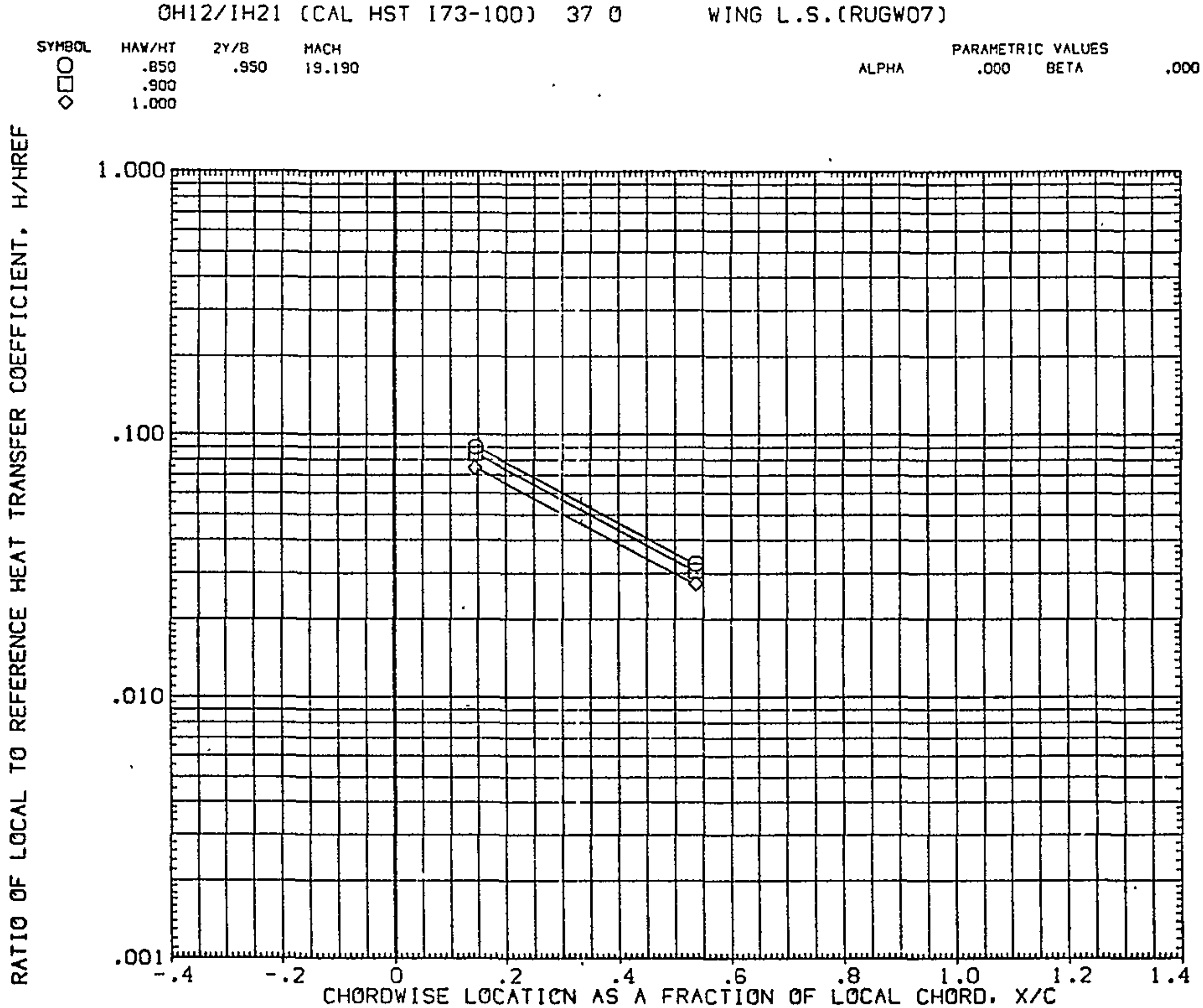

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

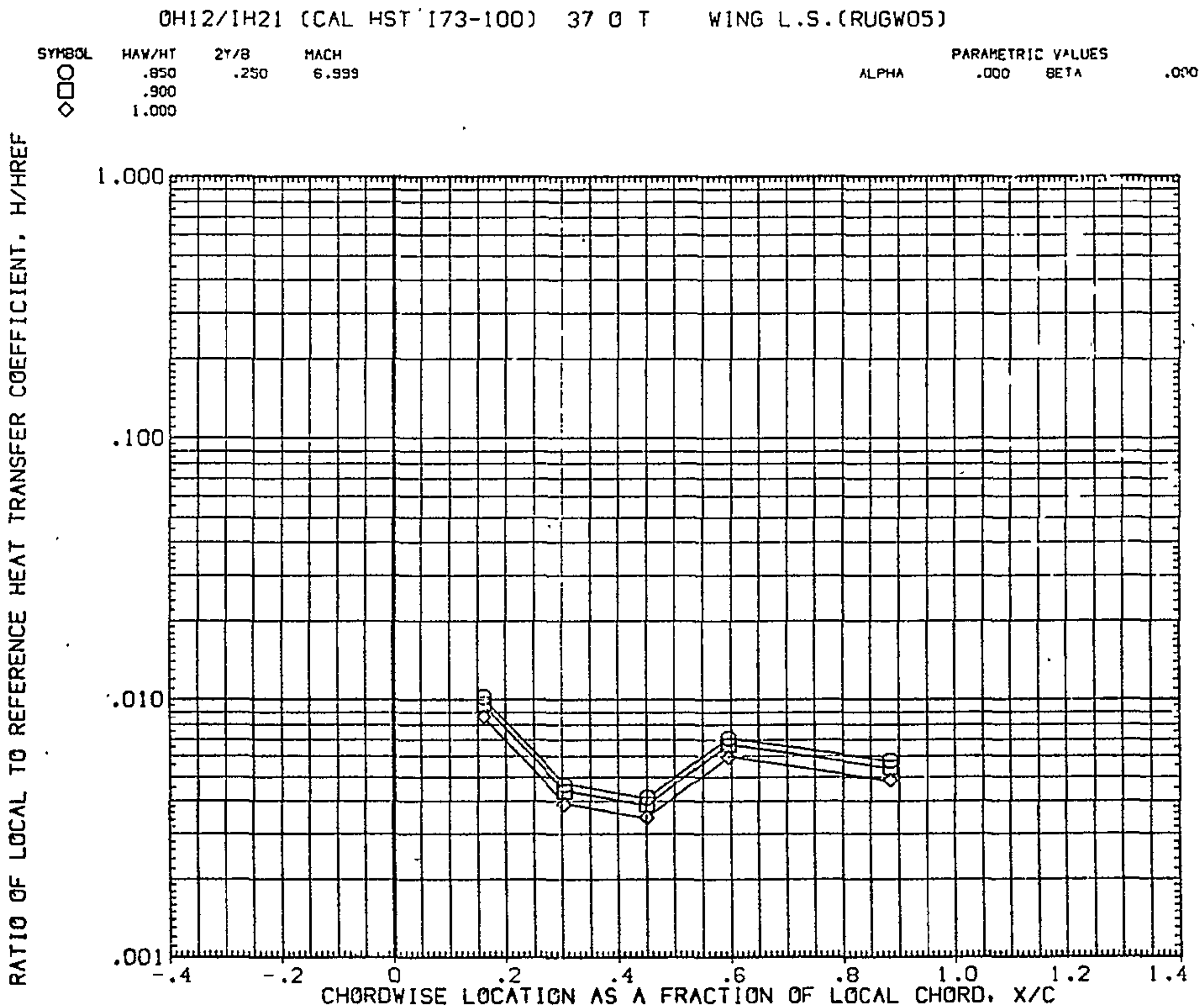

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

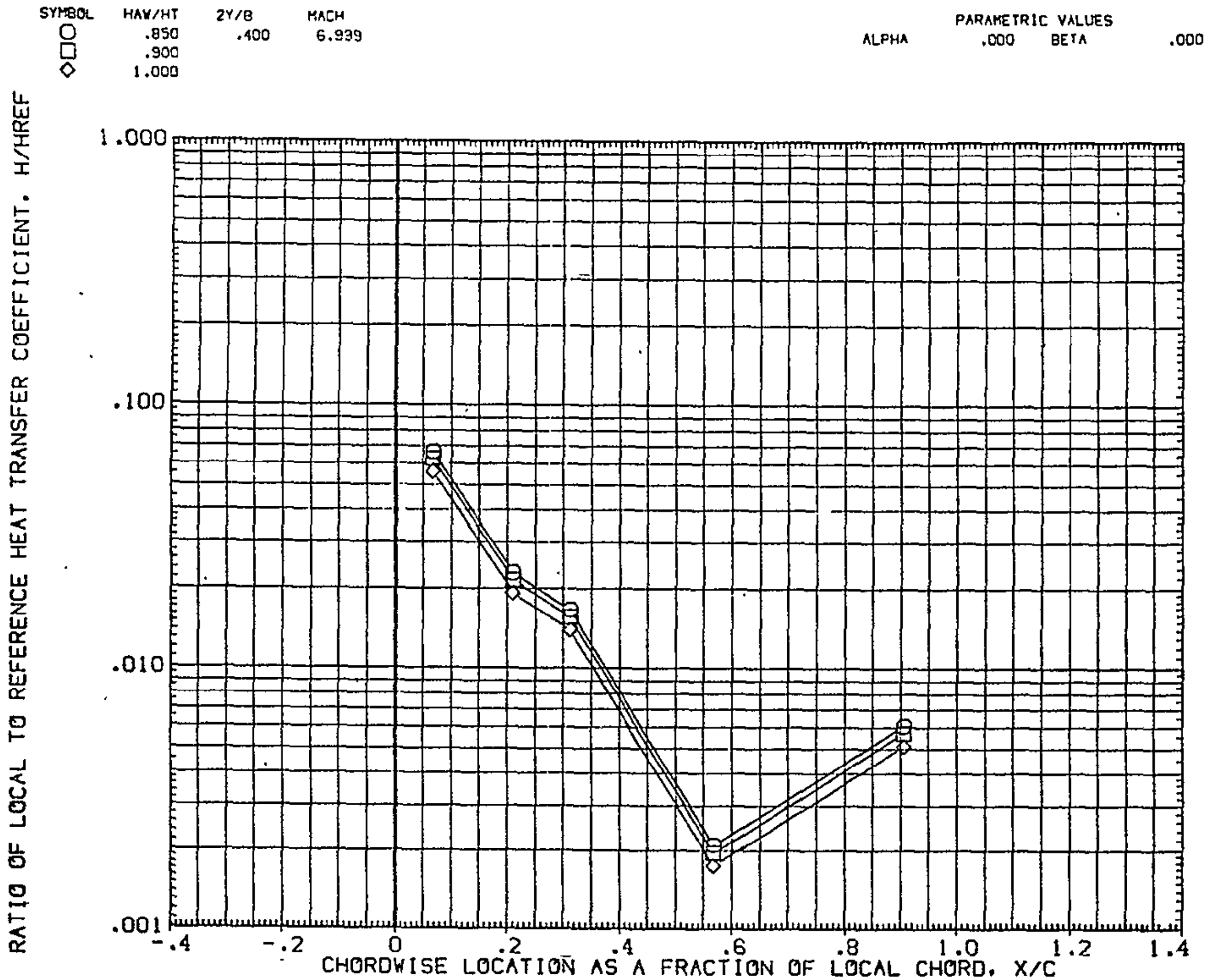

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

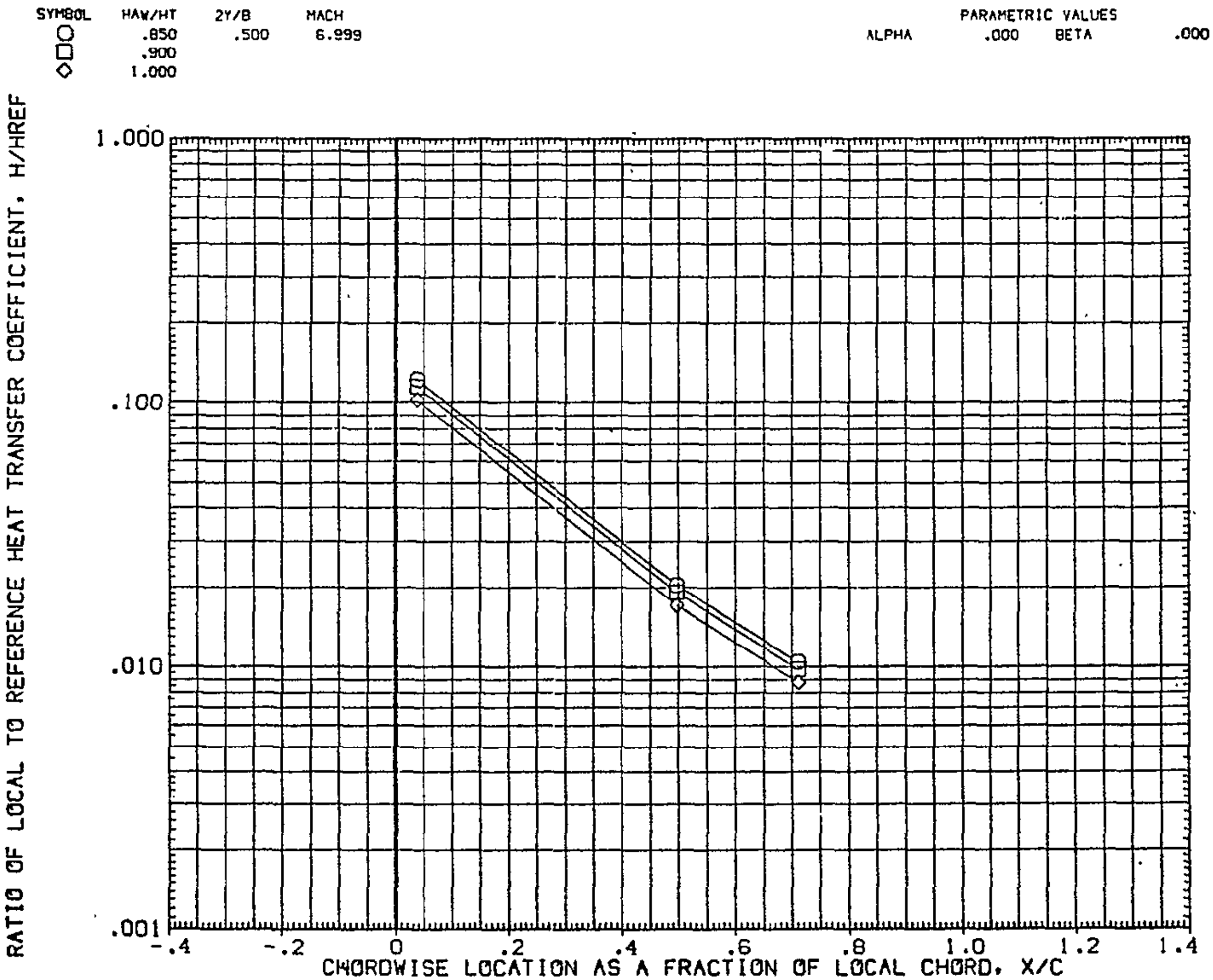

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

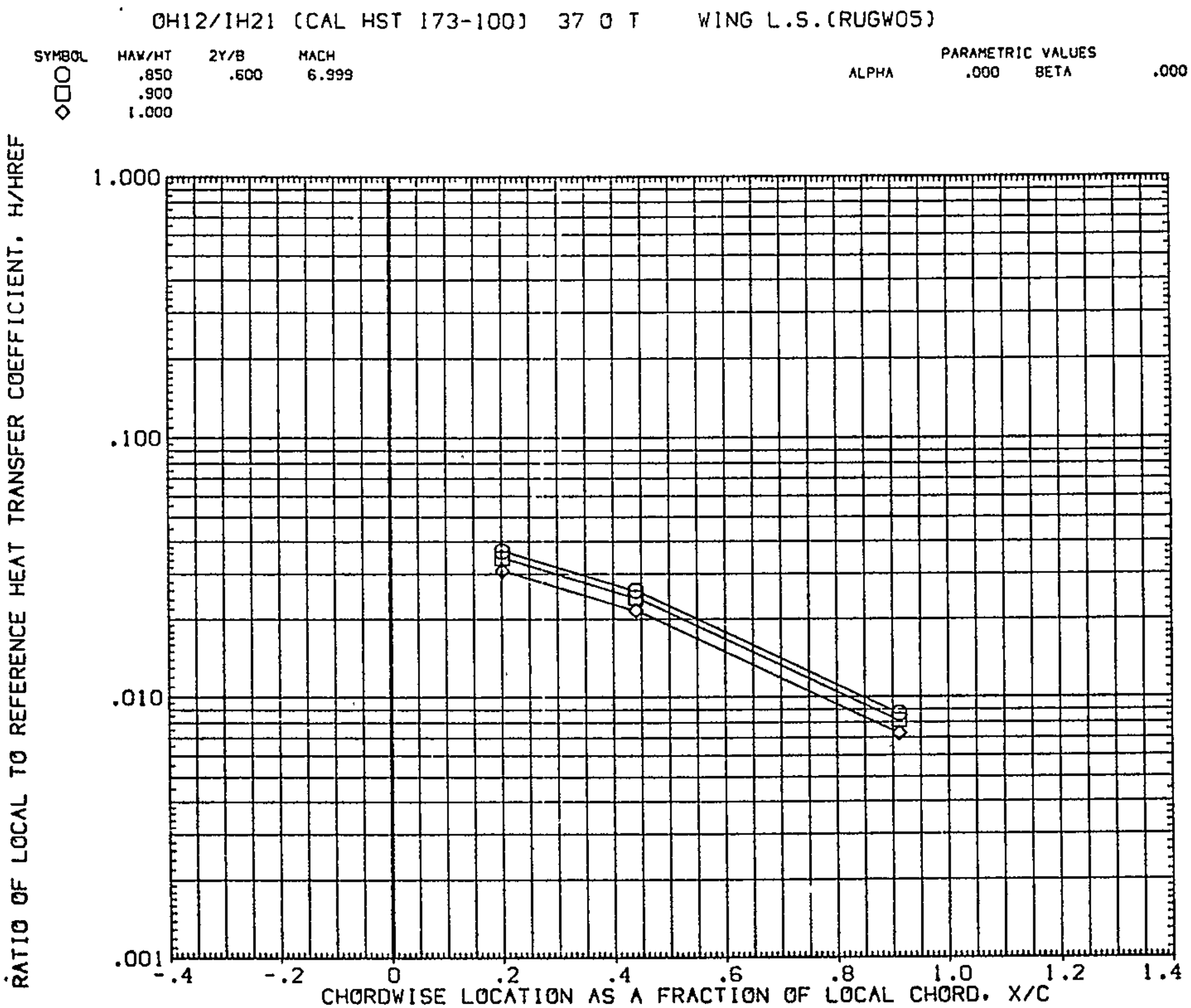

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T   WING L.S.(RUGWO5)

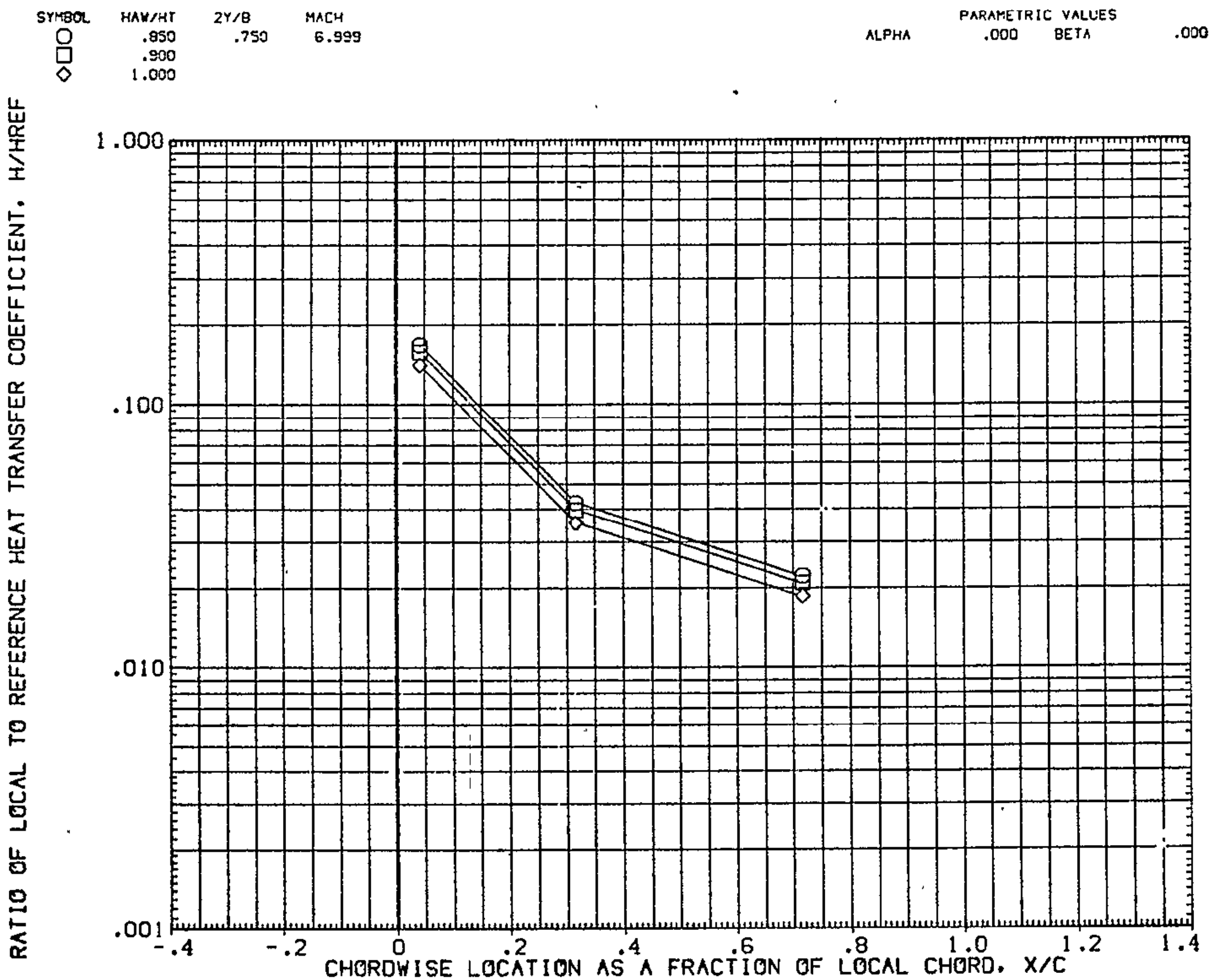

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

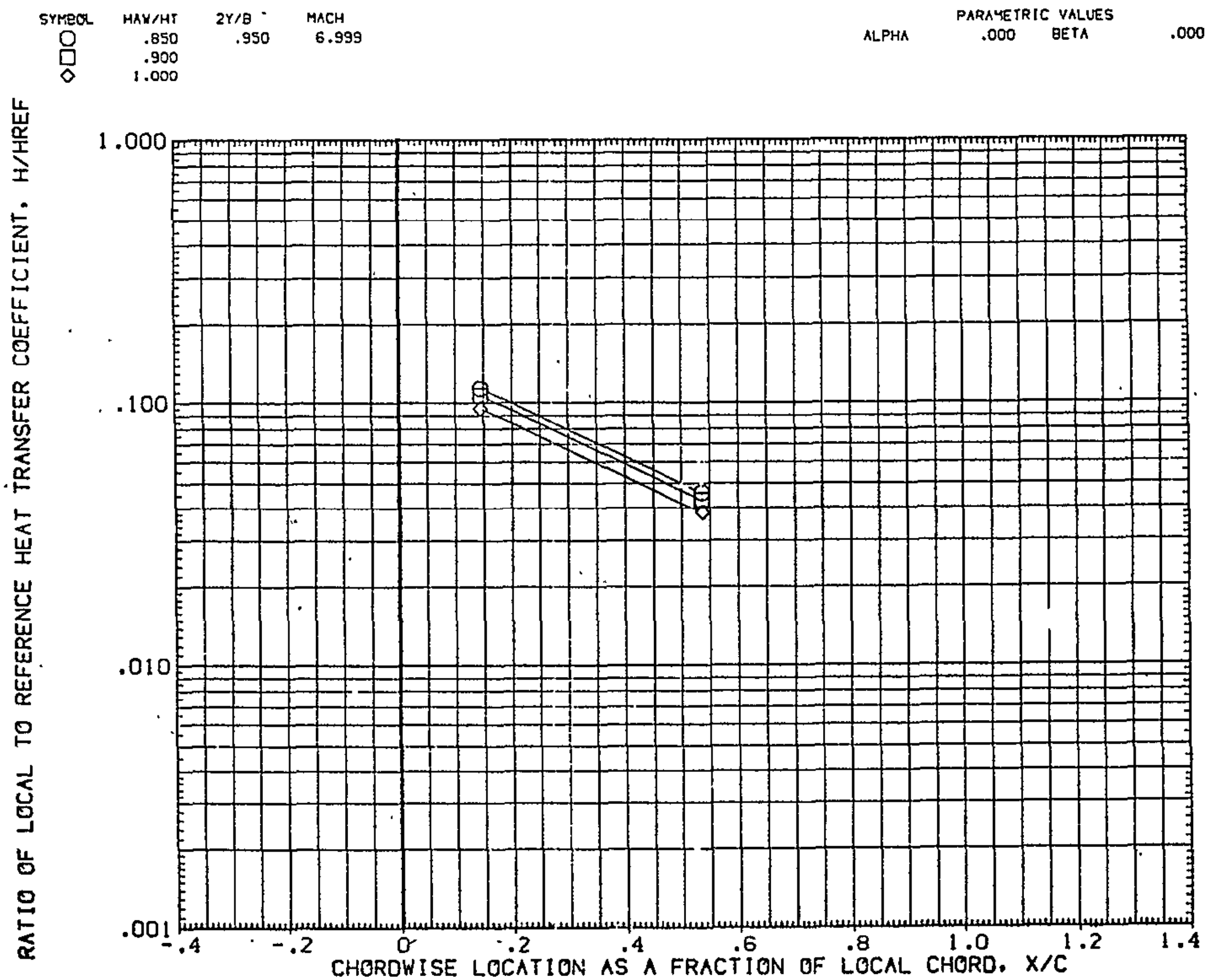

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

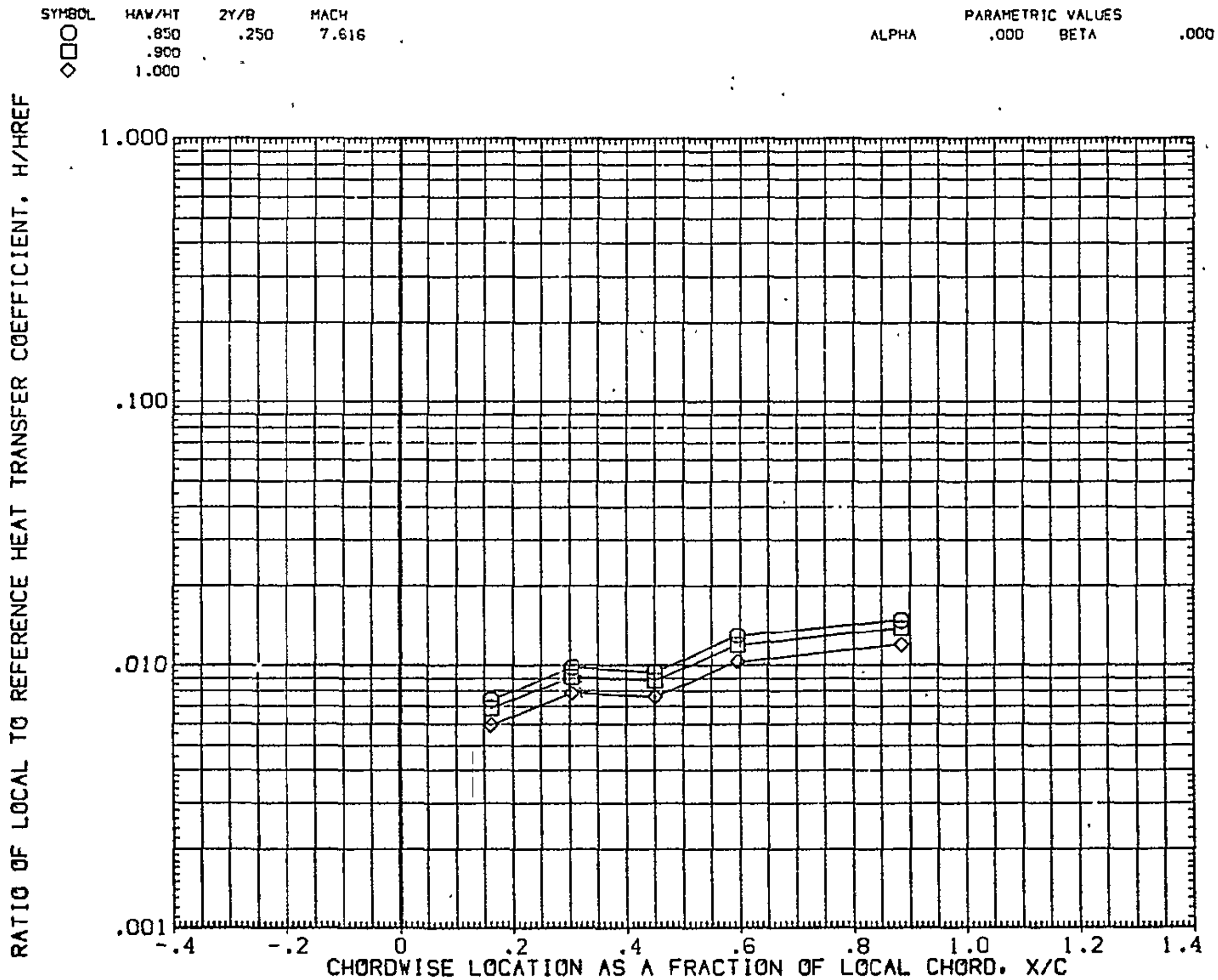

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

0H12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

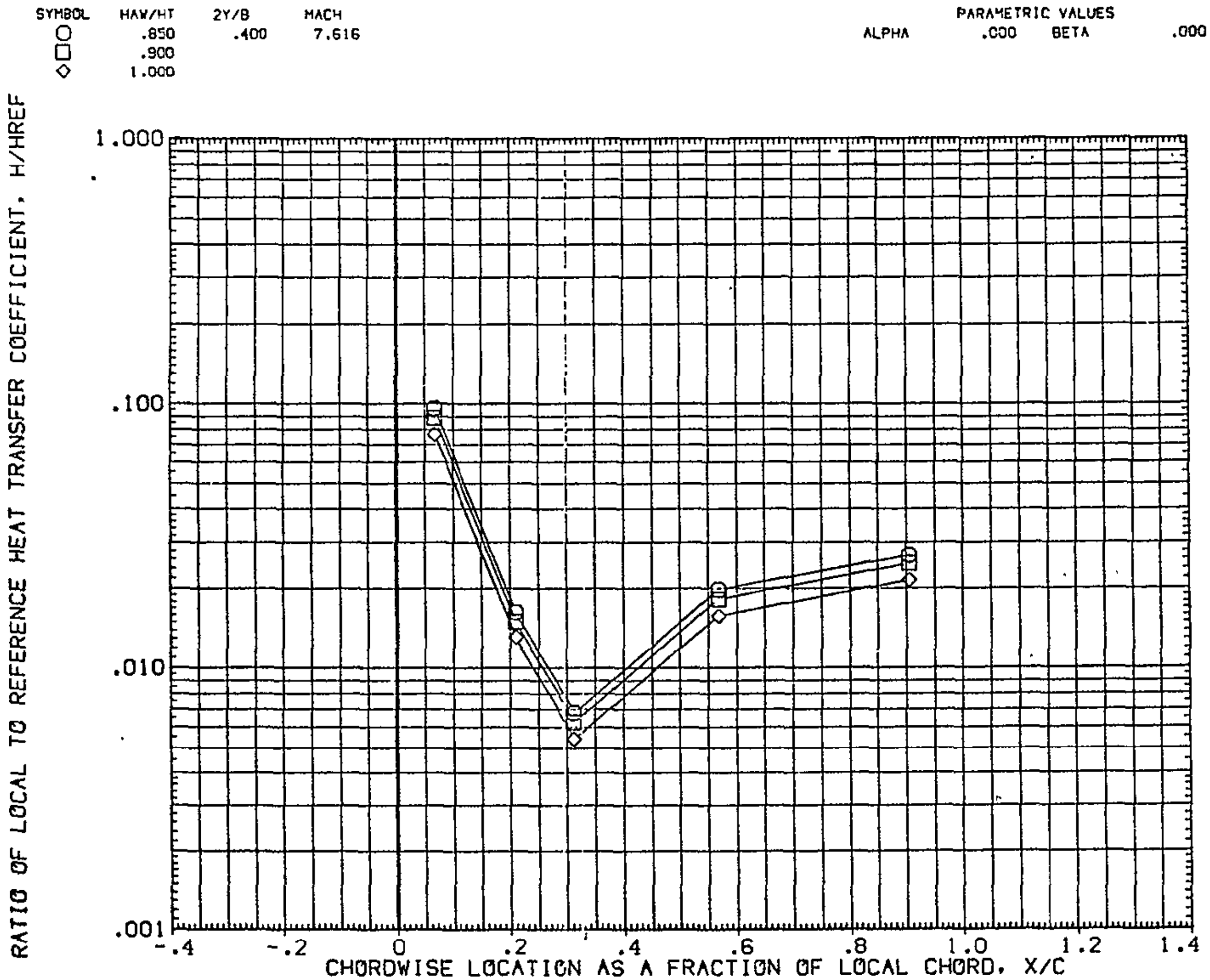

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

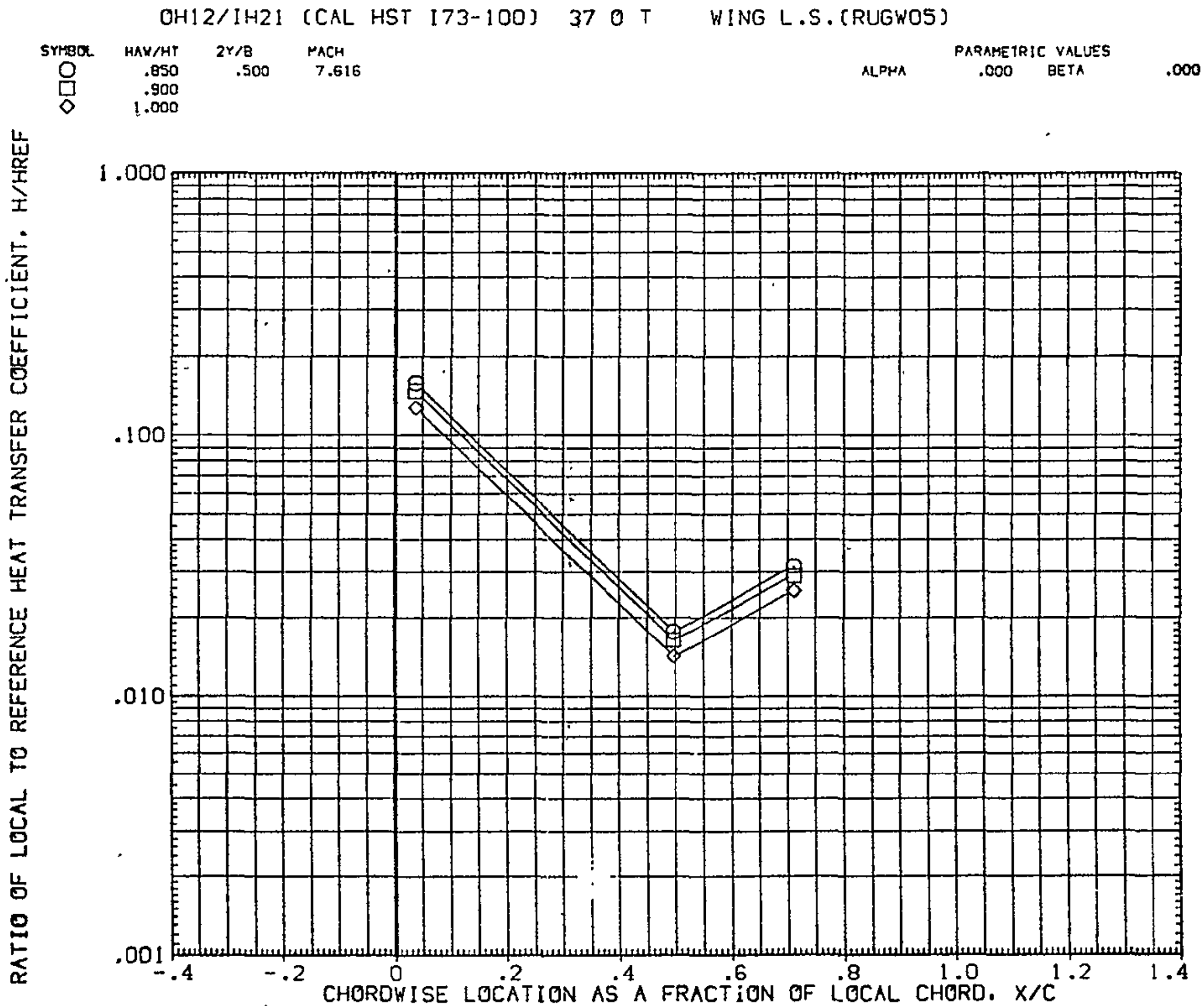

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

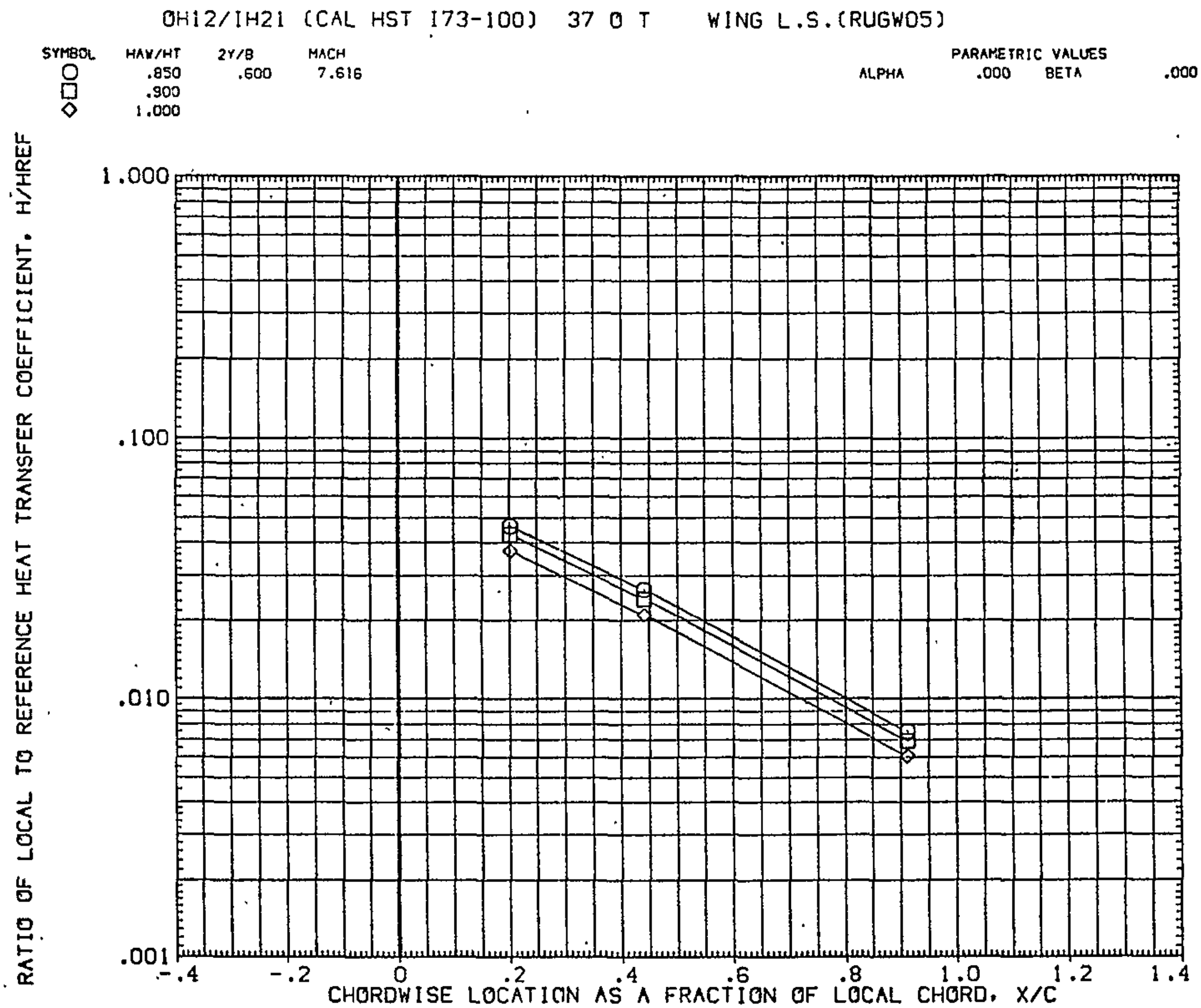

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

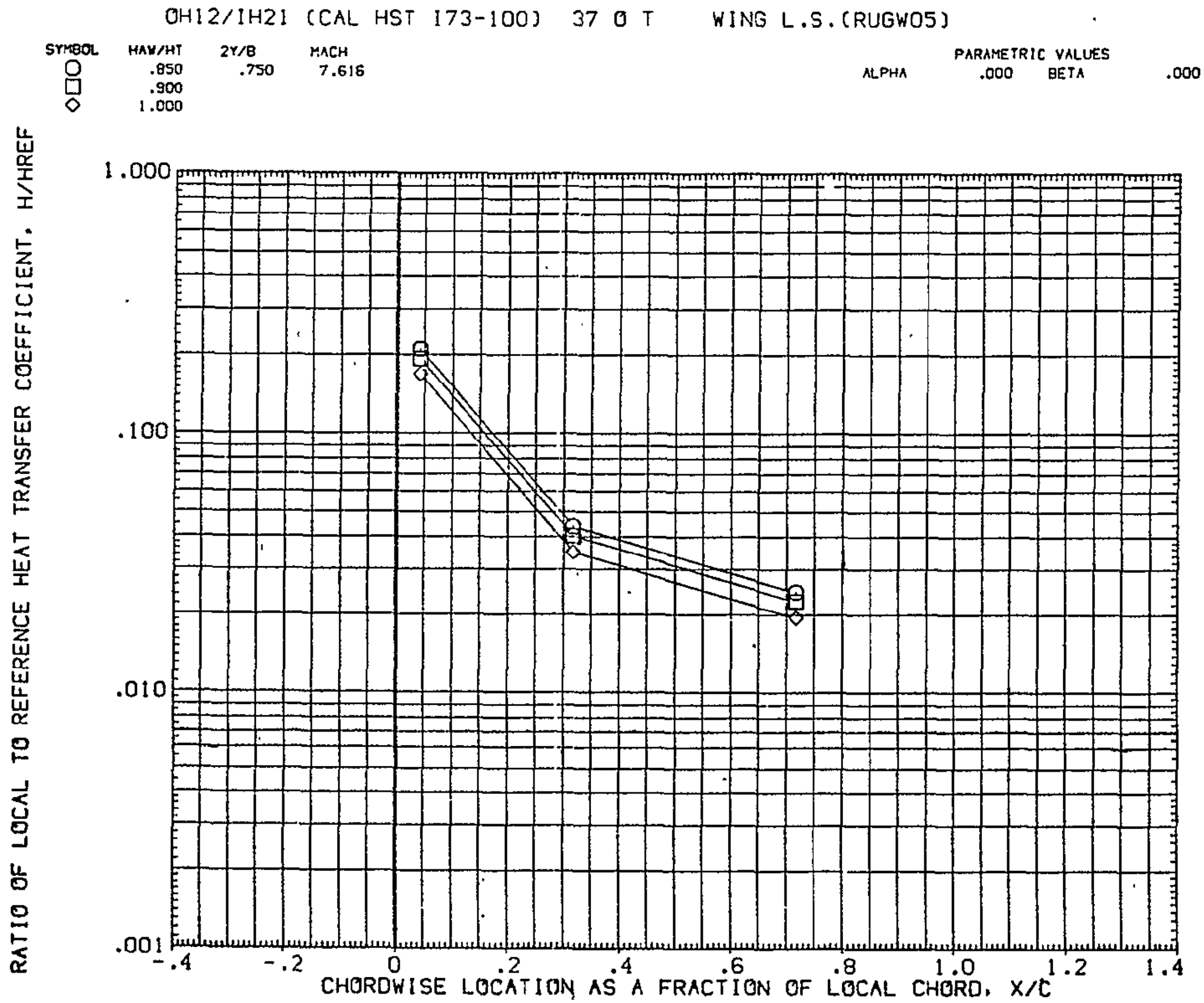

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

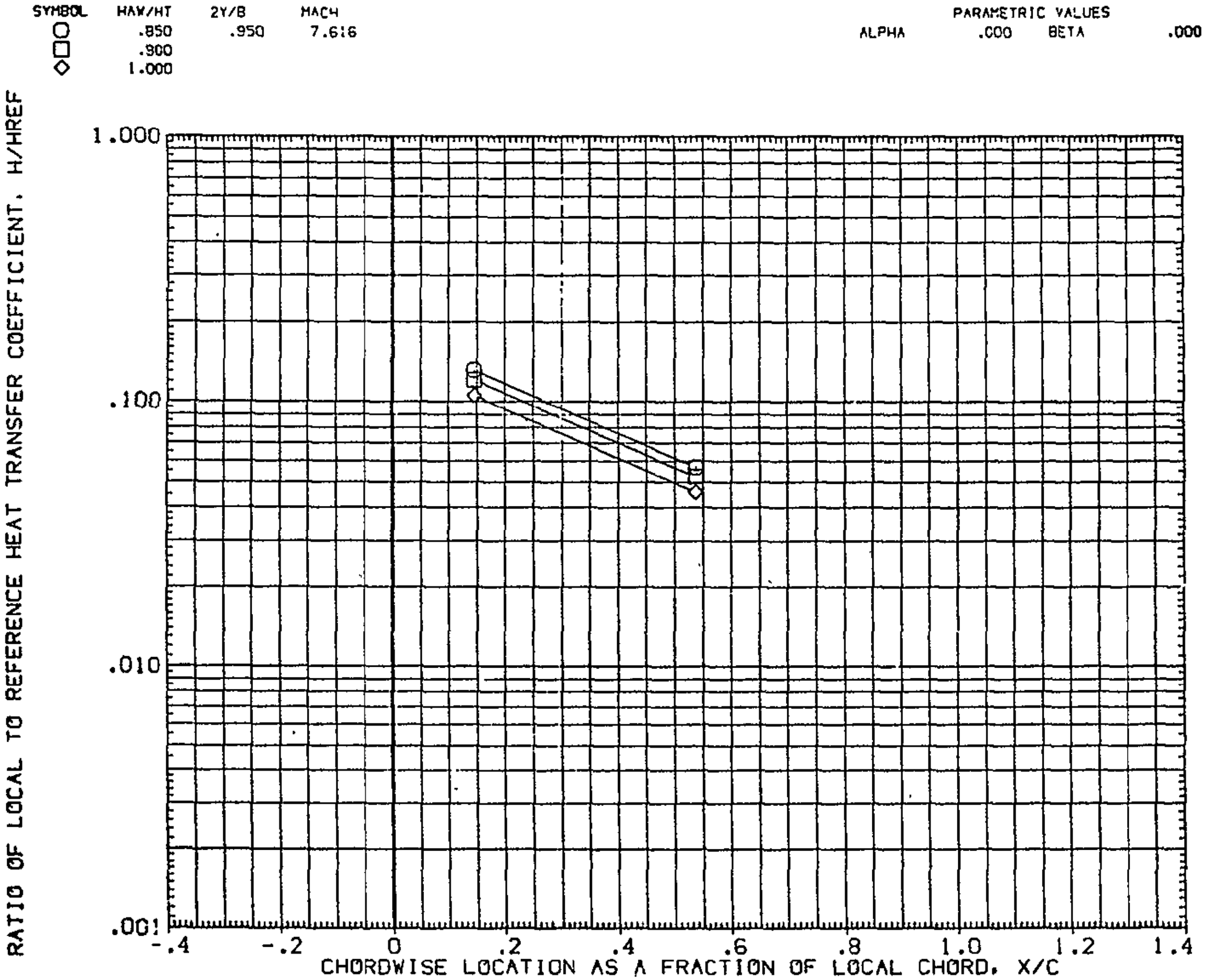

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

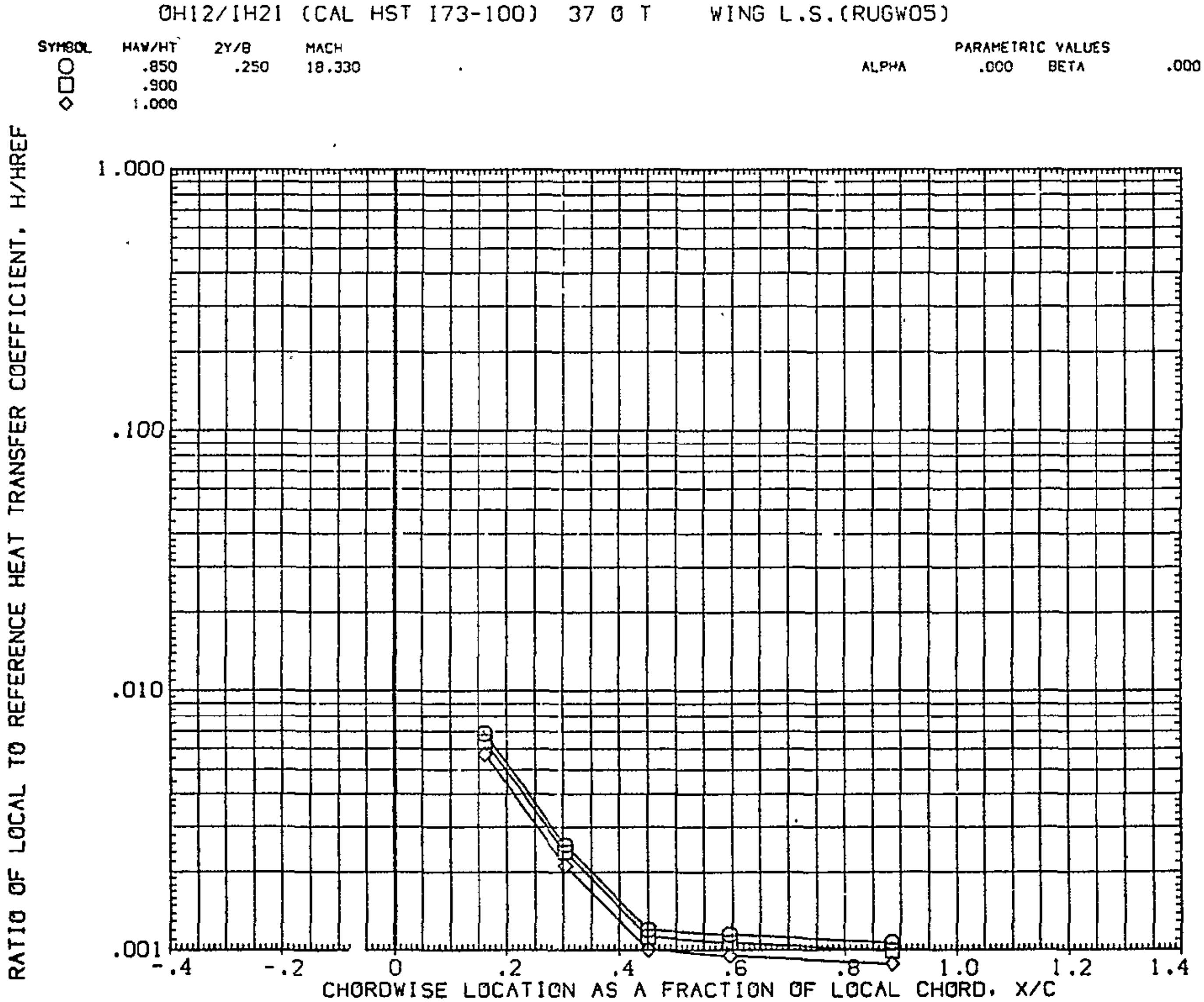

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA =.0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

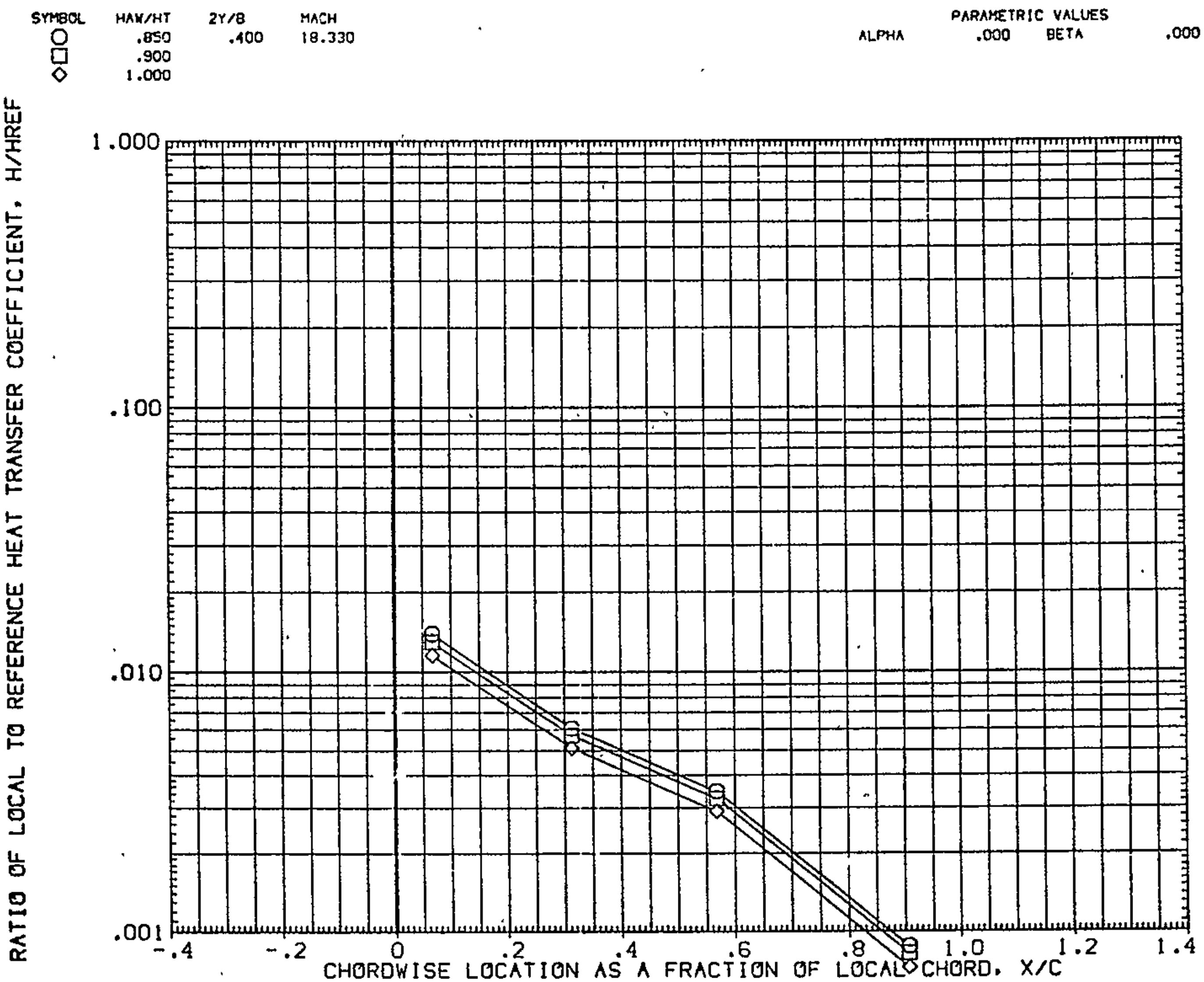

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

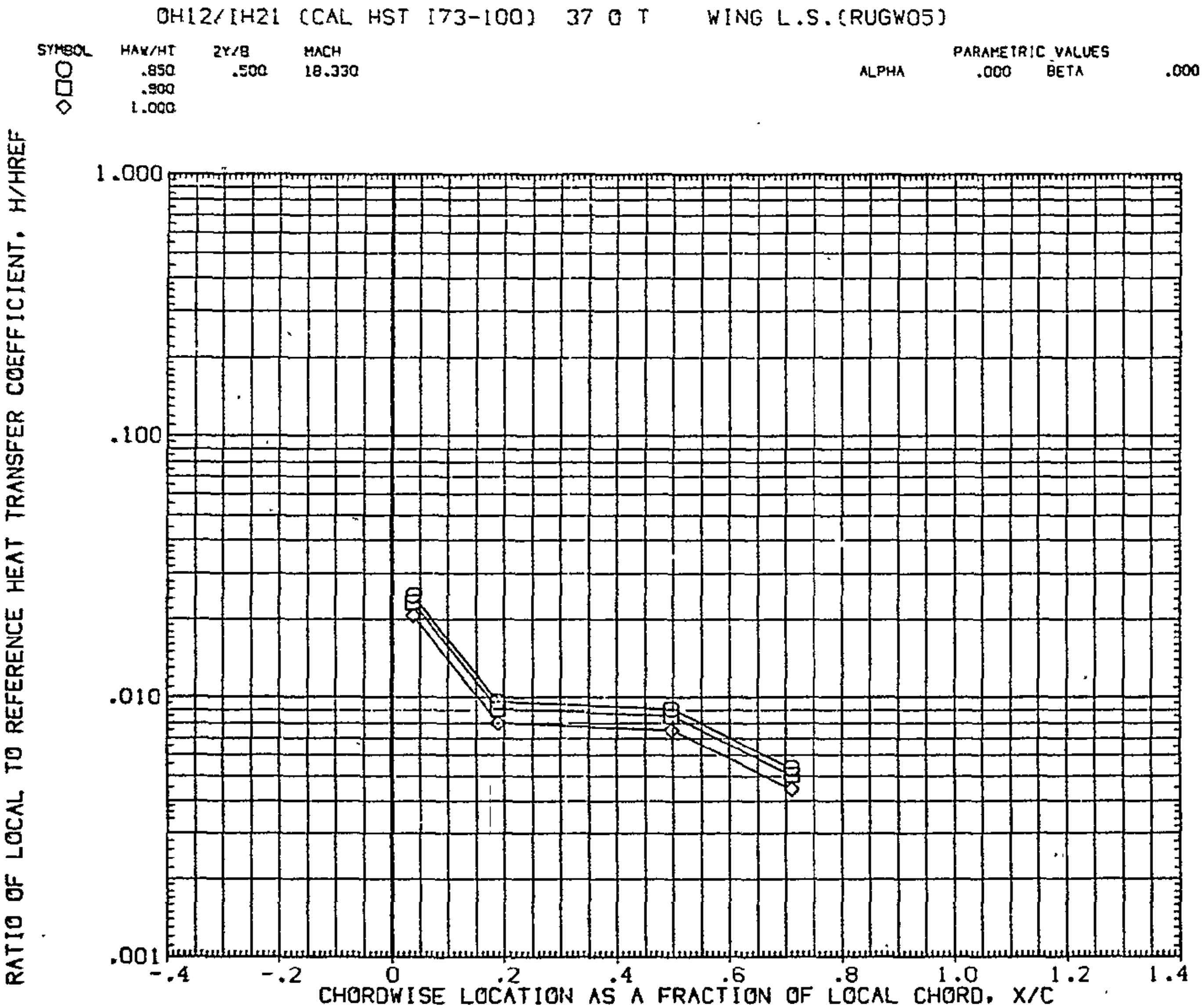

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

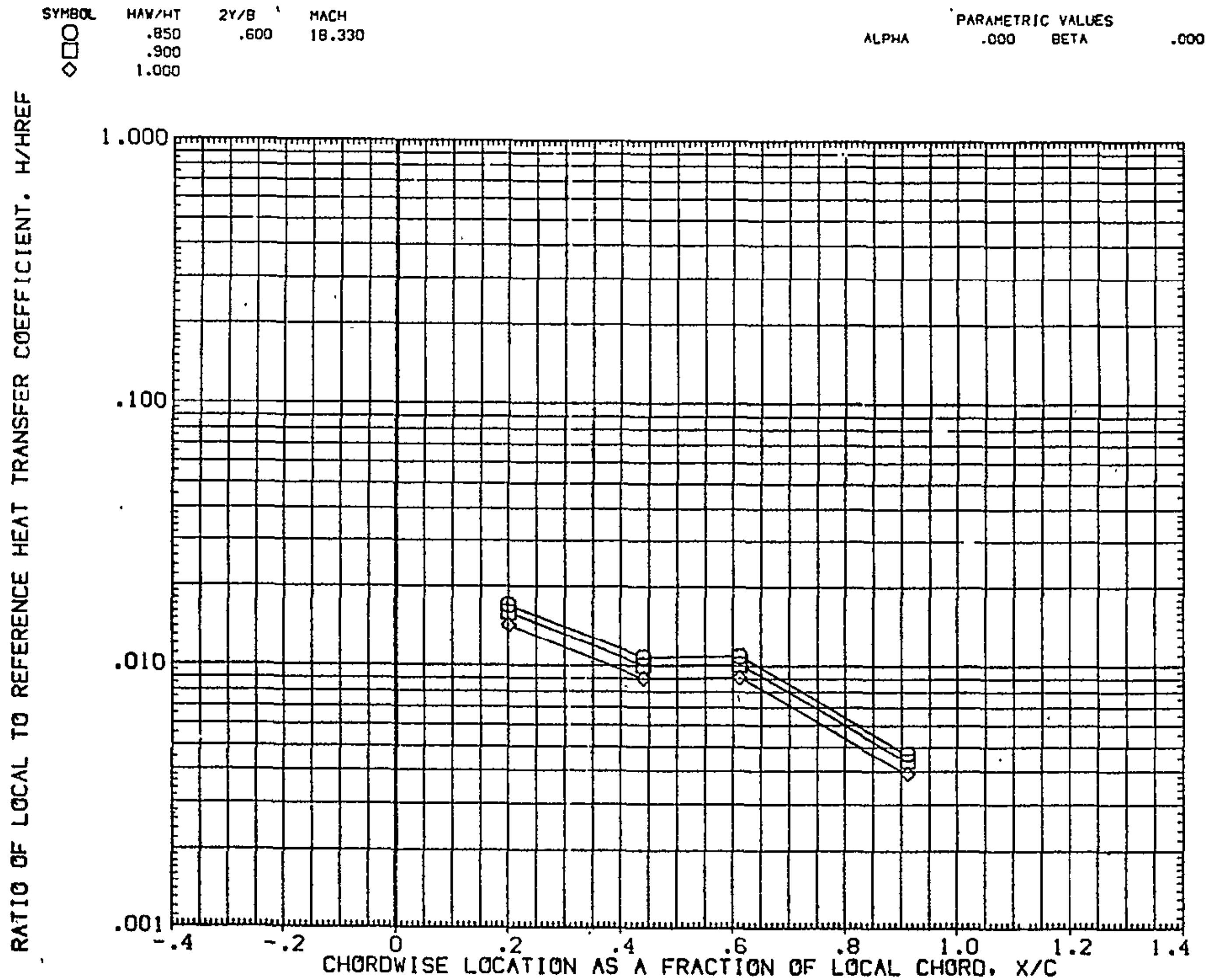

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

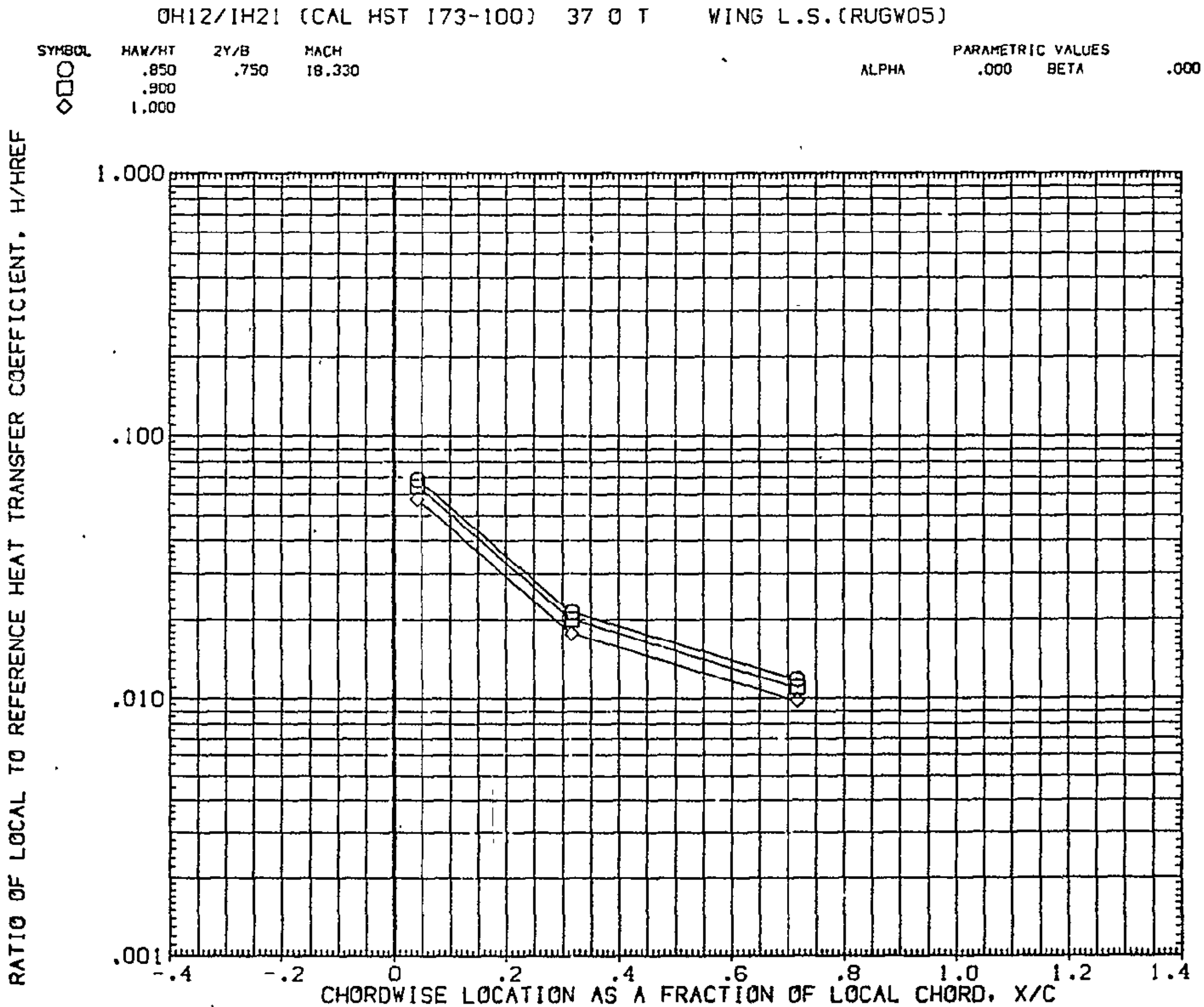

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

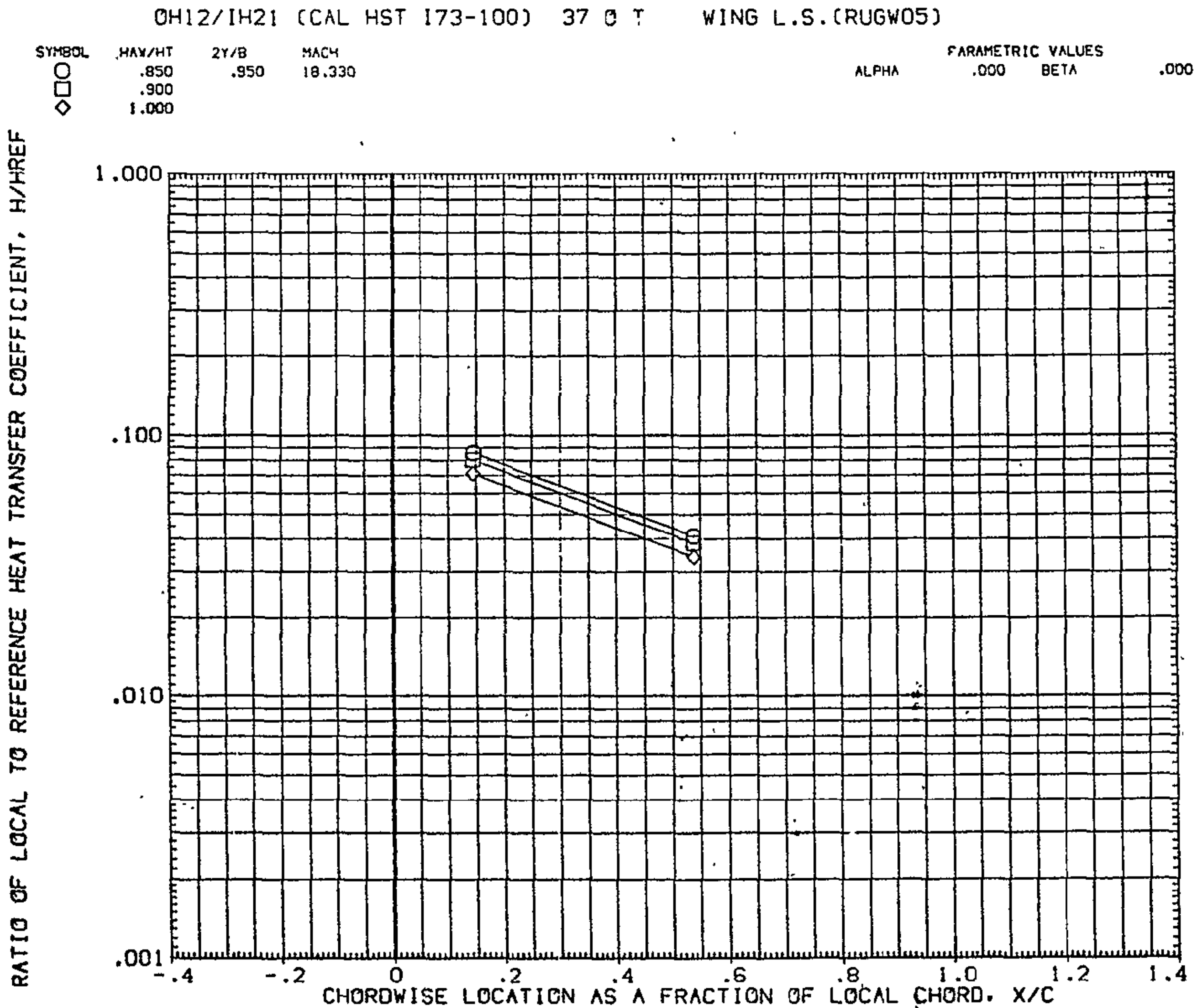

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

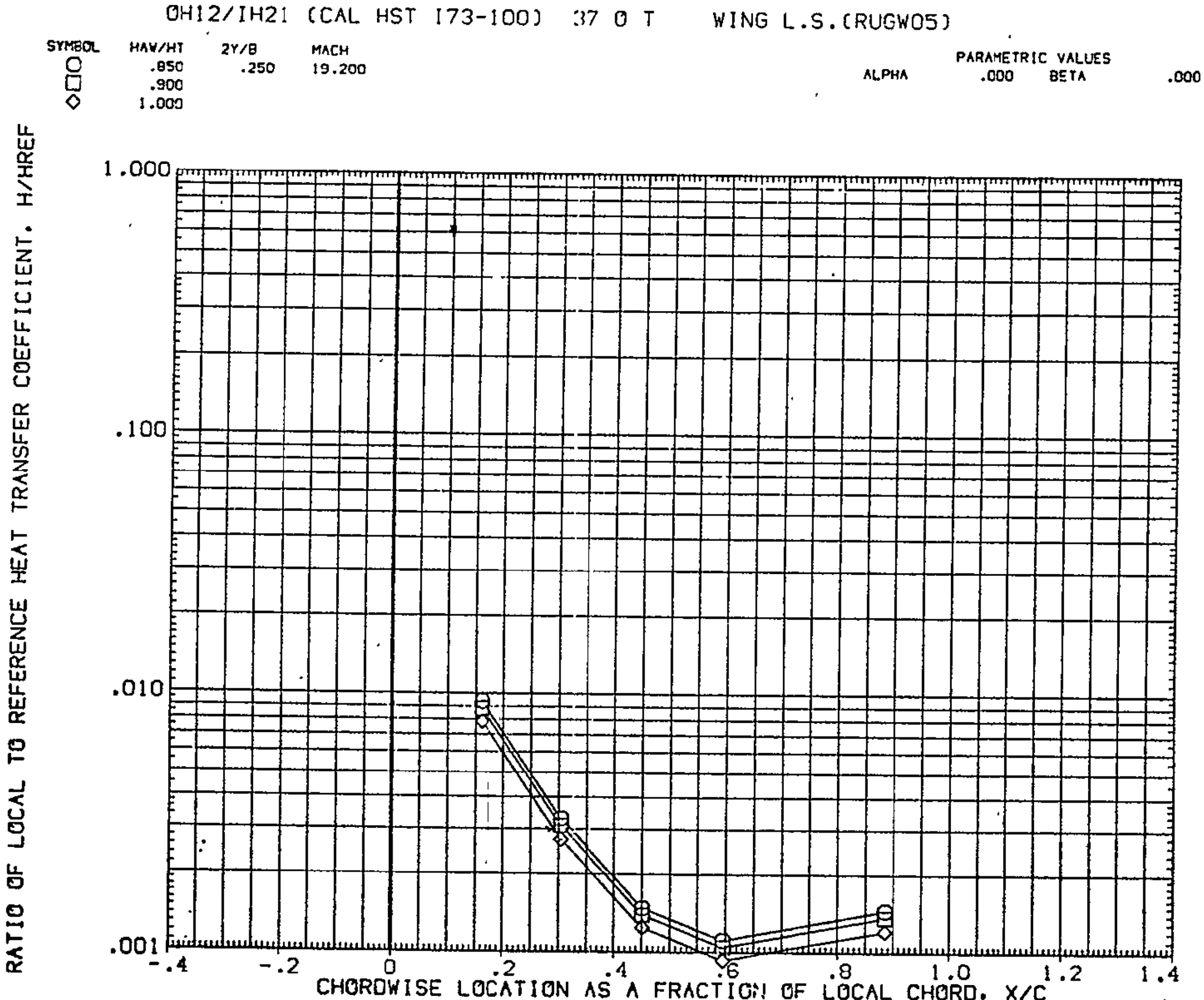

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T WING L.S.(RUGW05)

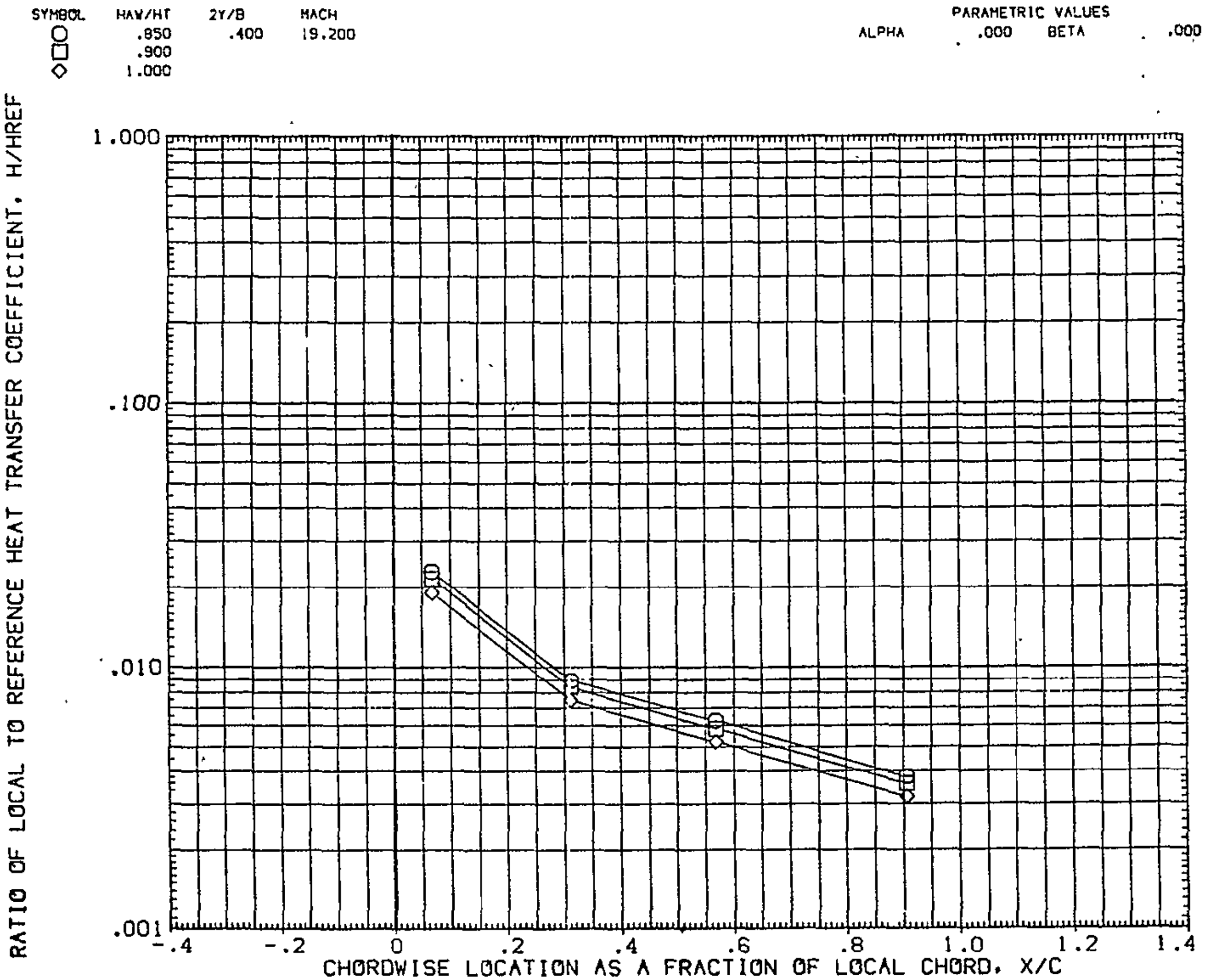

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW05)

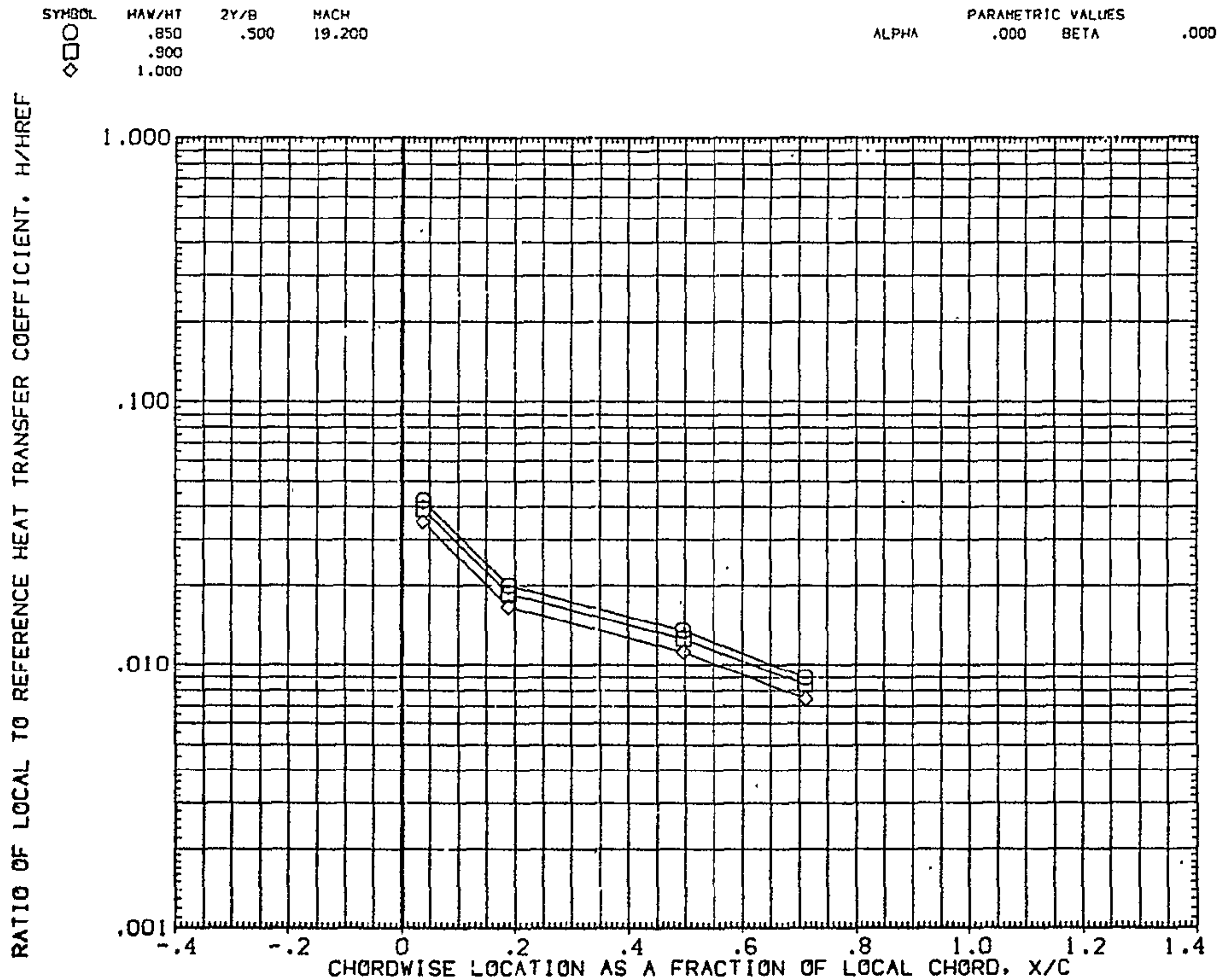

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

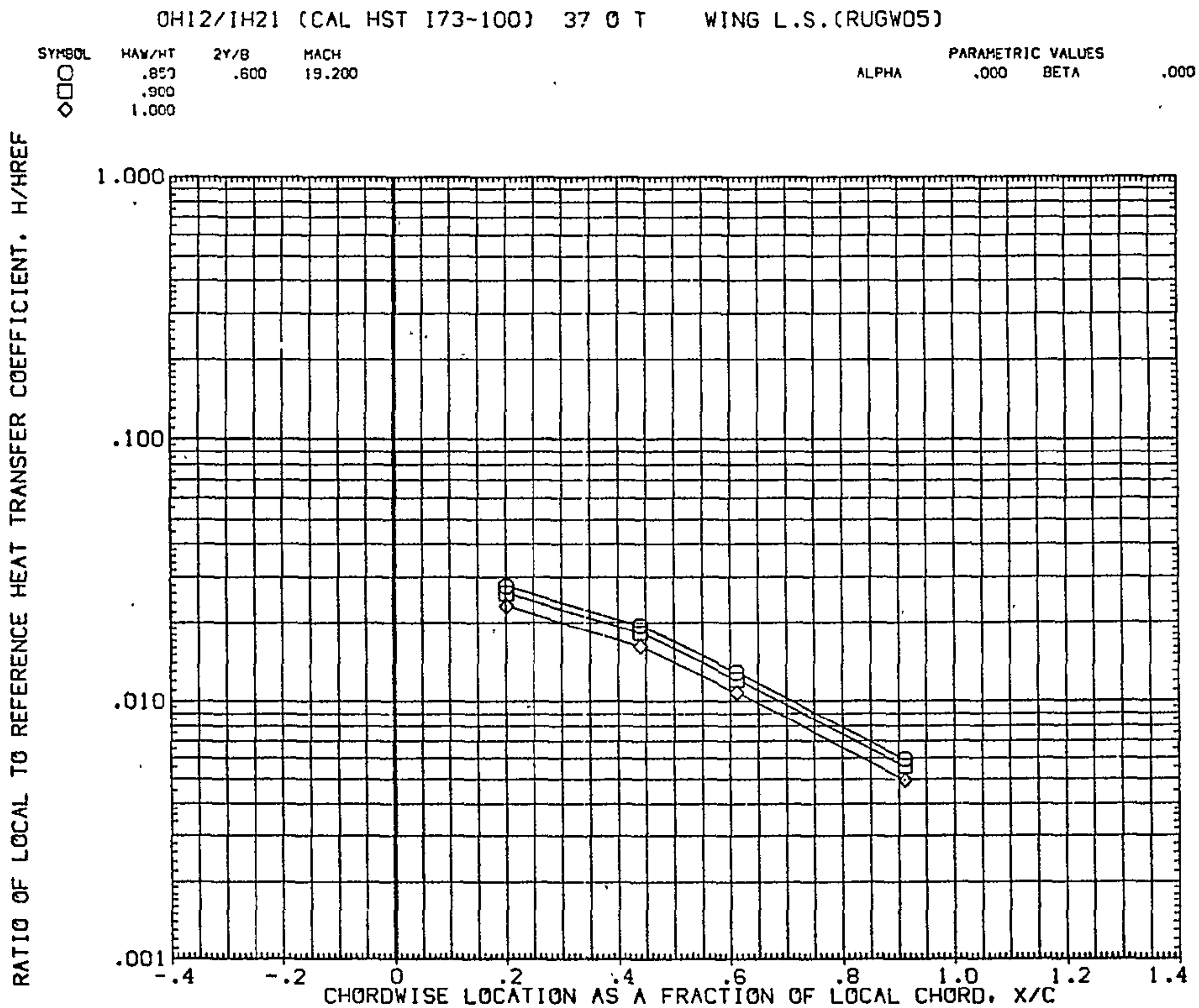

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

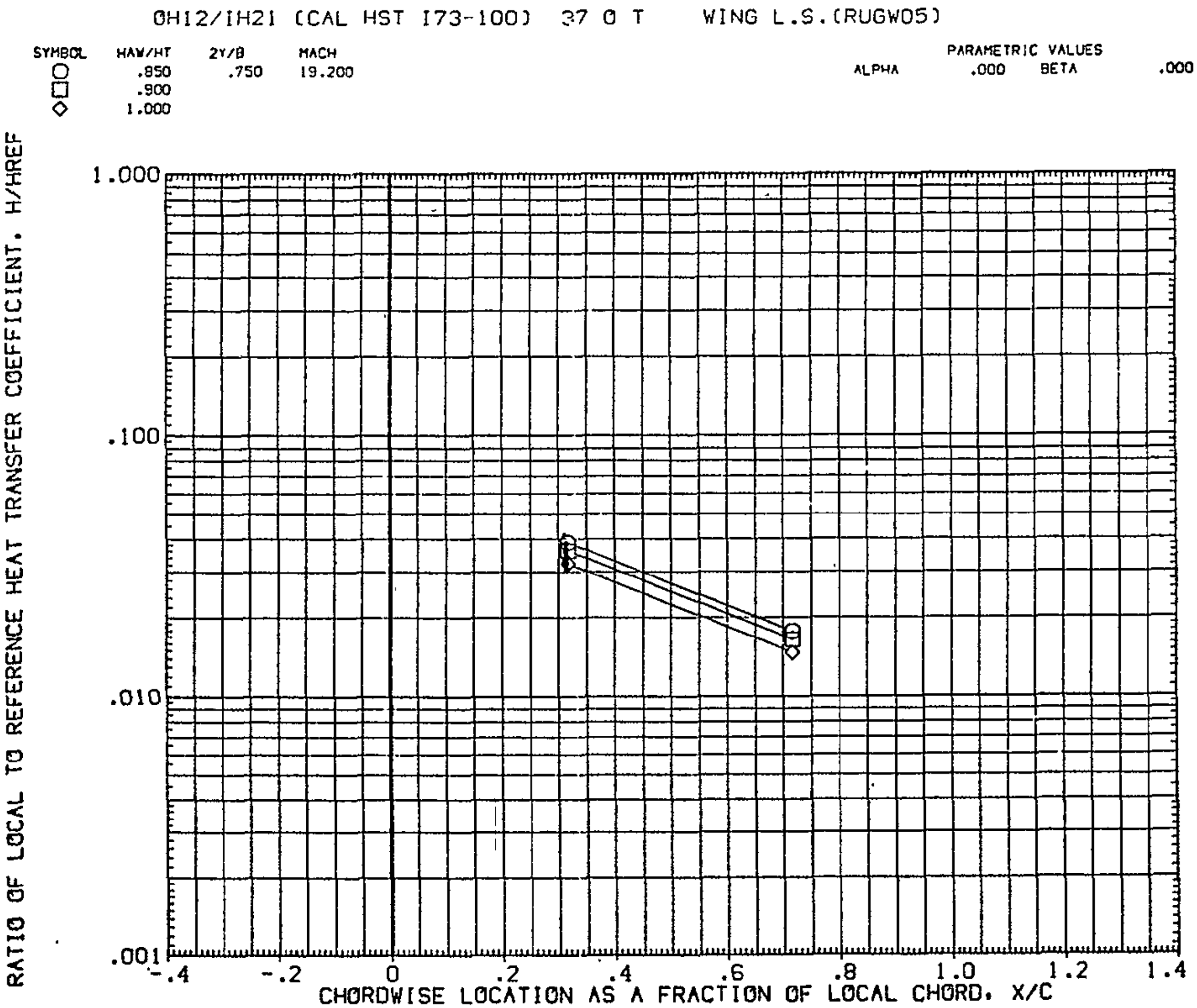

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = .0

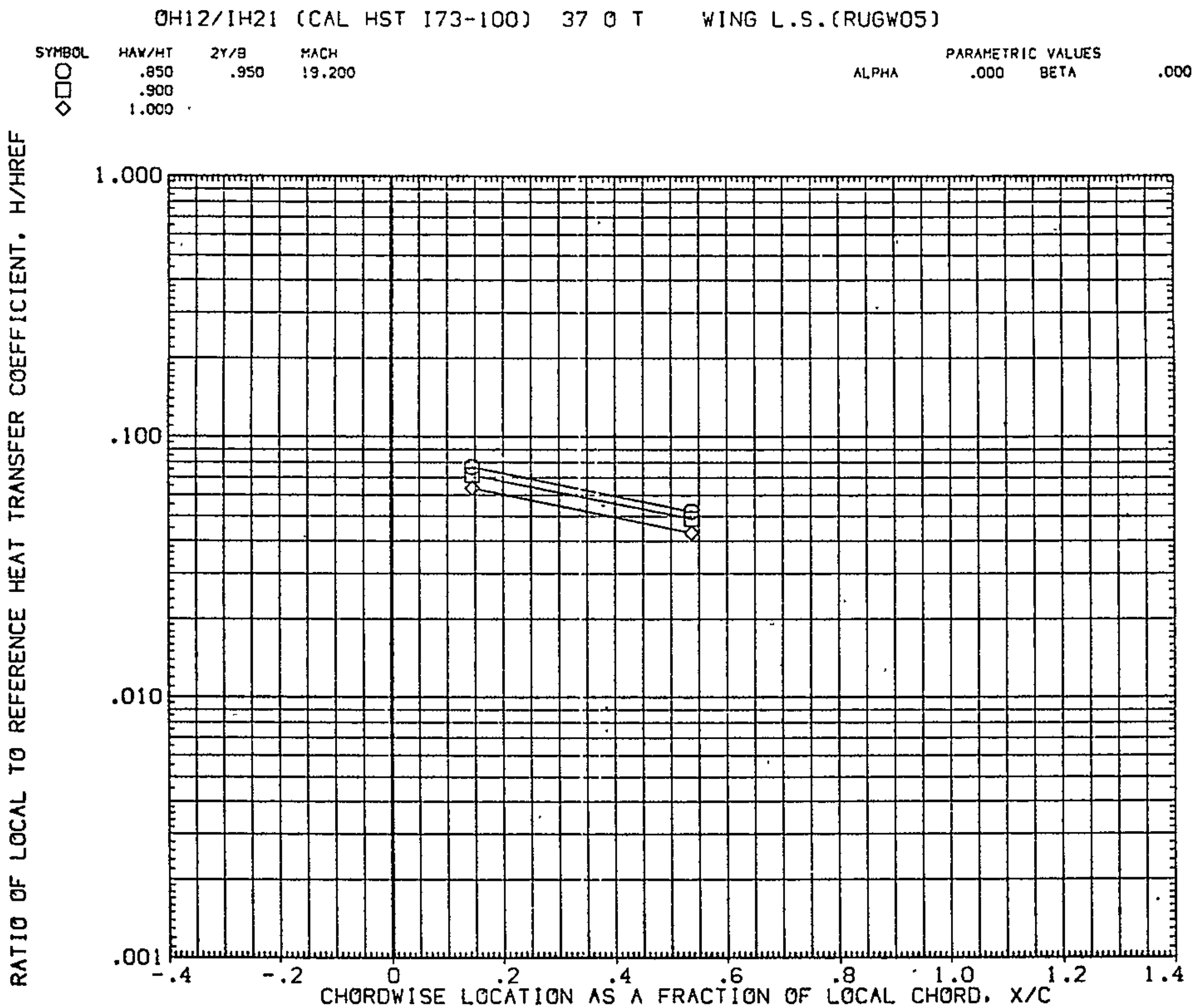

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 0T(05)/0(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.250	7.000

PARAMETRIC VALUES

ALPHA .000 BETA .000

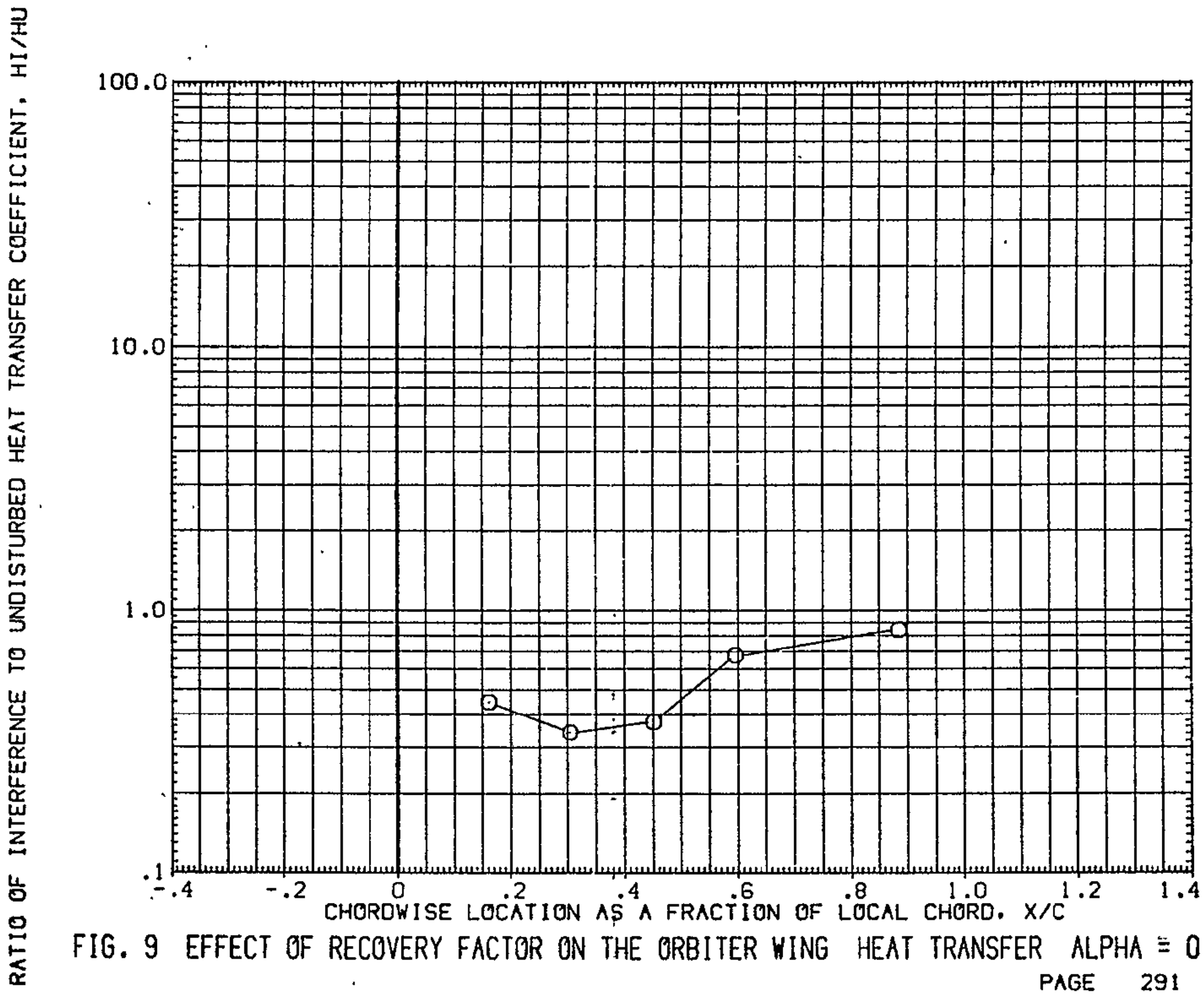

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.400	7.000

PARAMETRIC VALUES
ALPHA .000 BETA .000

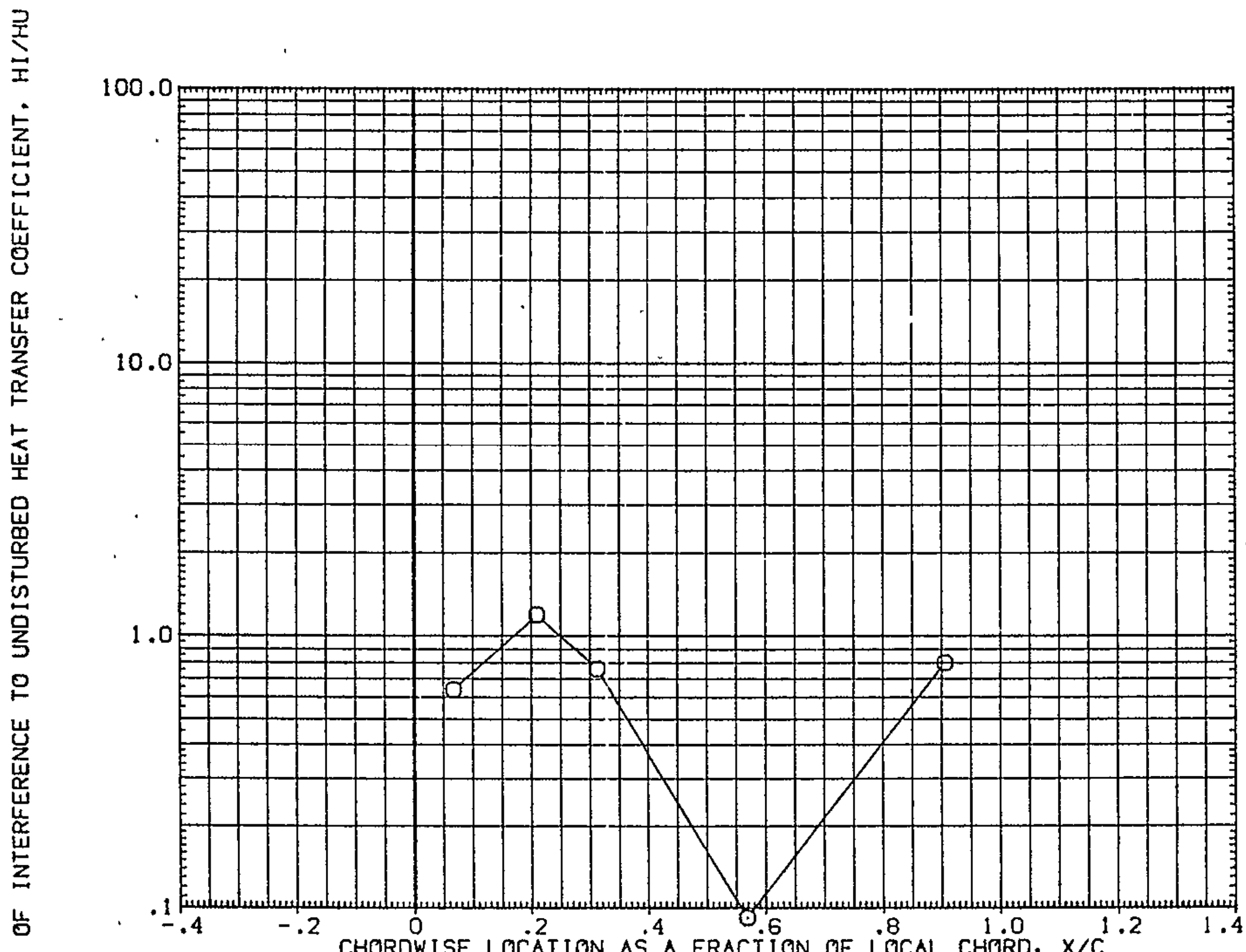

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

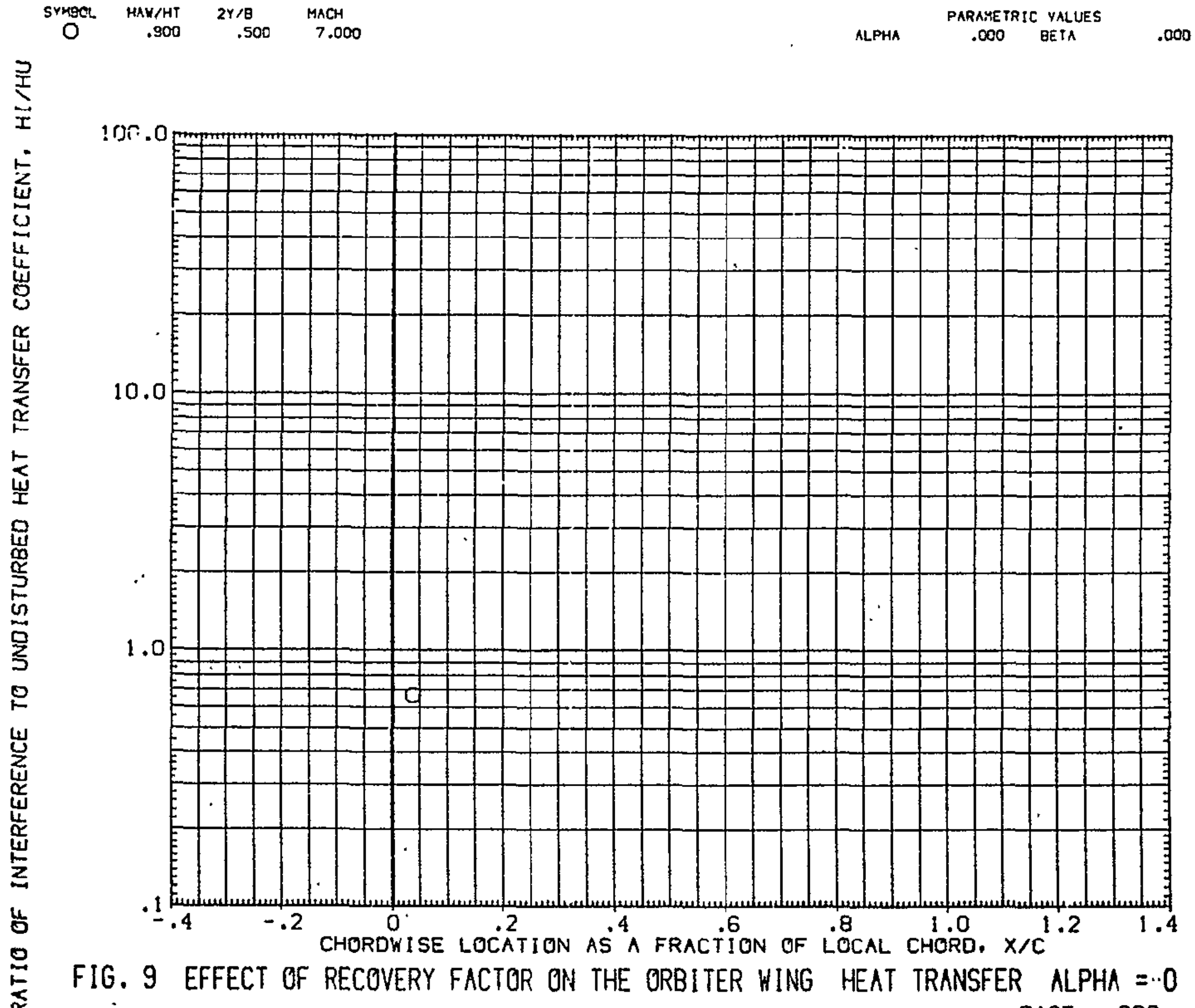

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

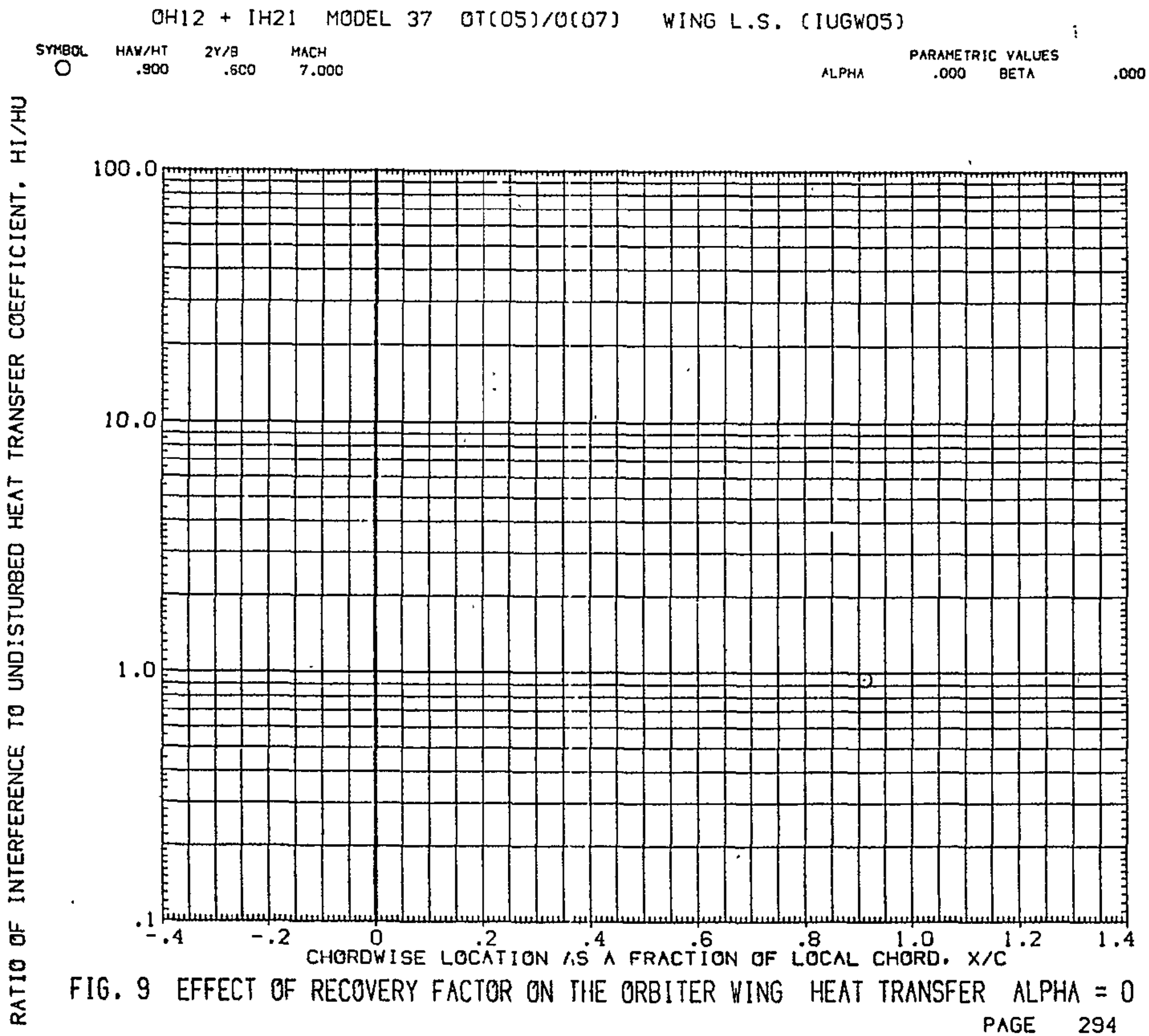

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.750	7.000

PARAMETRIC VALUES

ALPHA .000 BETA .000

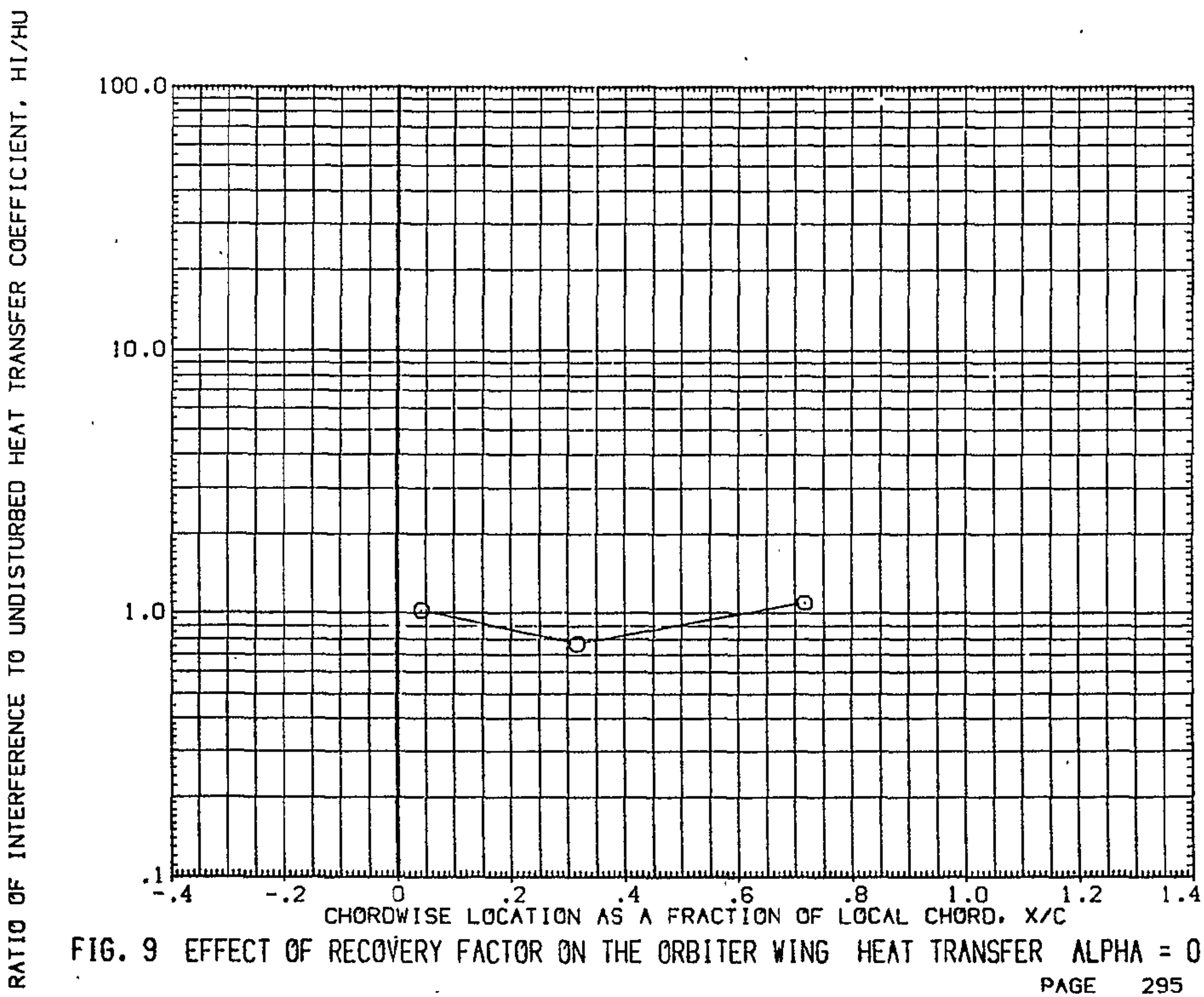

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

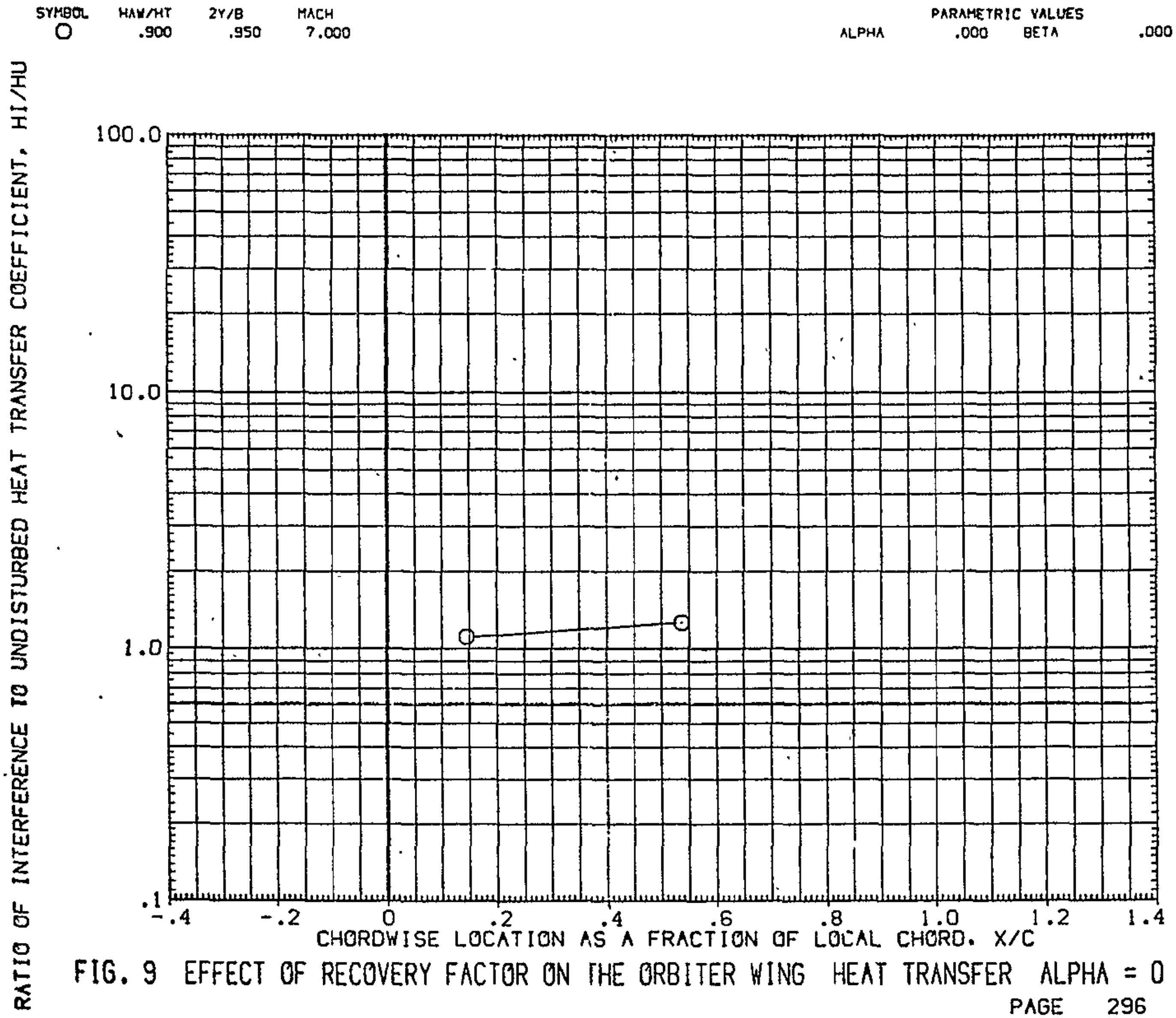

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.250	7.610

PARAMETRIC VALUES
ALPHA .000 BETA .000

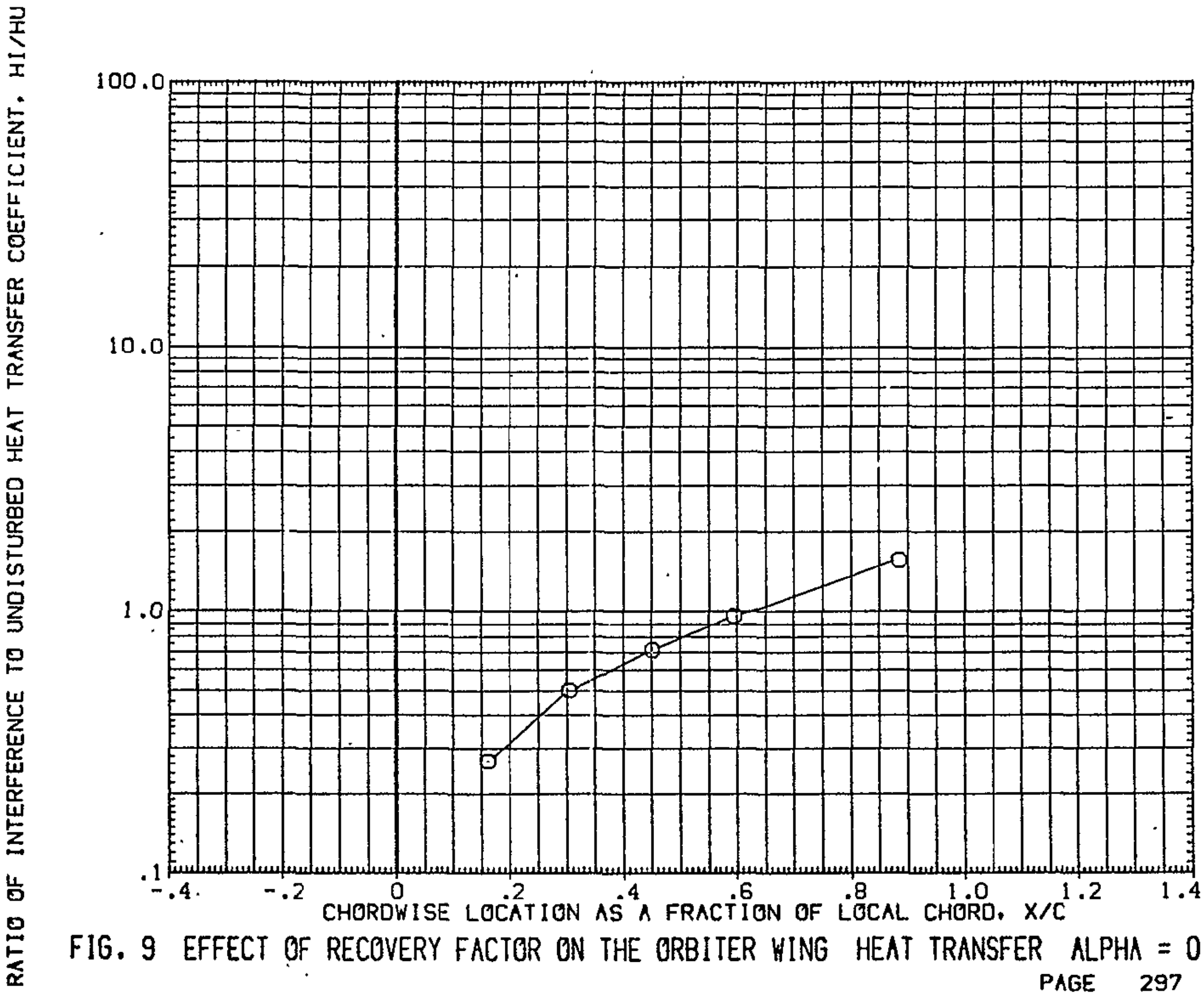

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

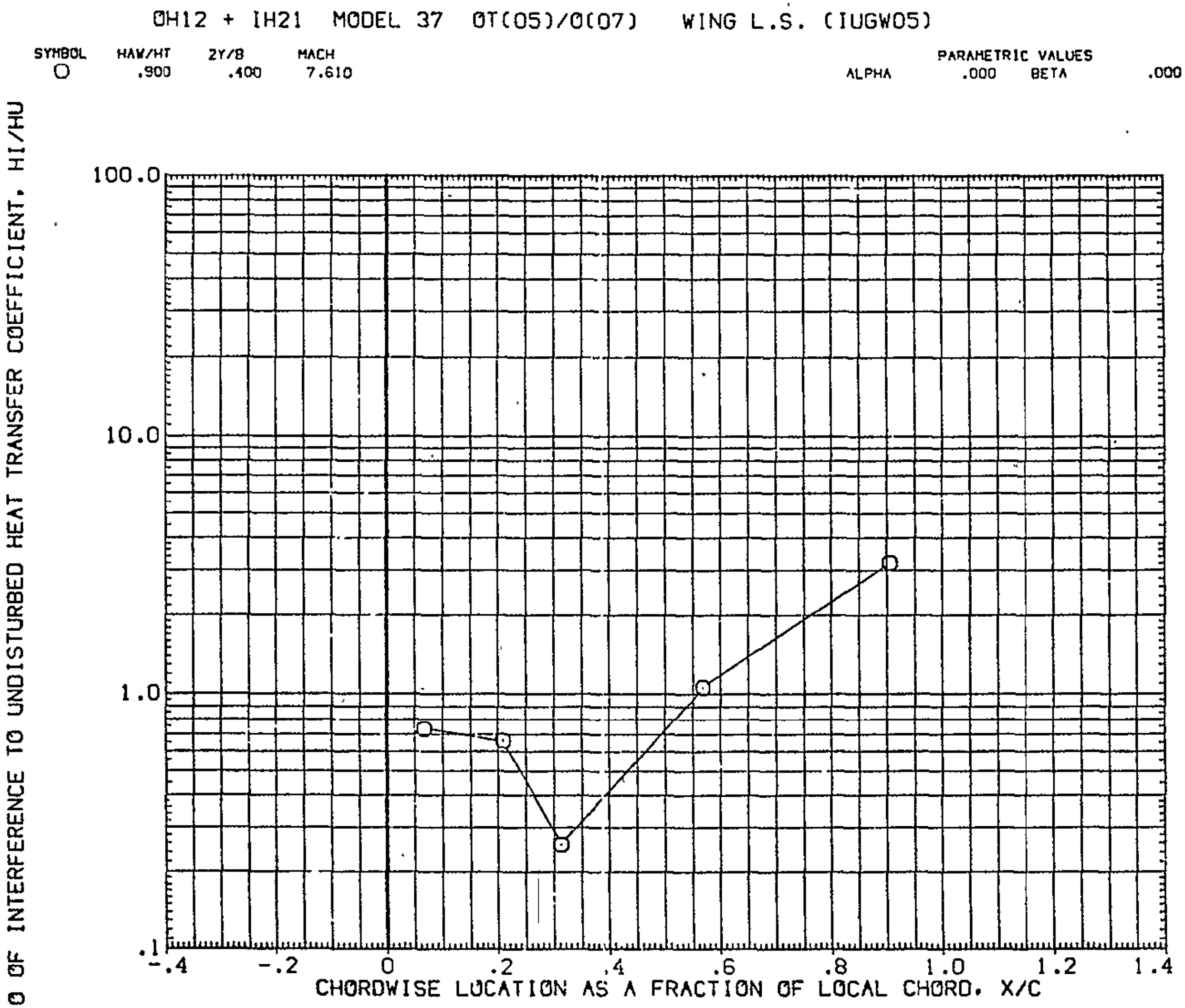

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
○	.900	.500	7.610

PARAMETRIC VALUES
ALPHA .000 BETA .000

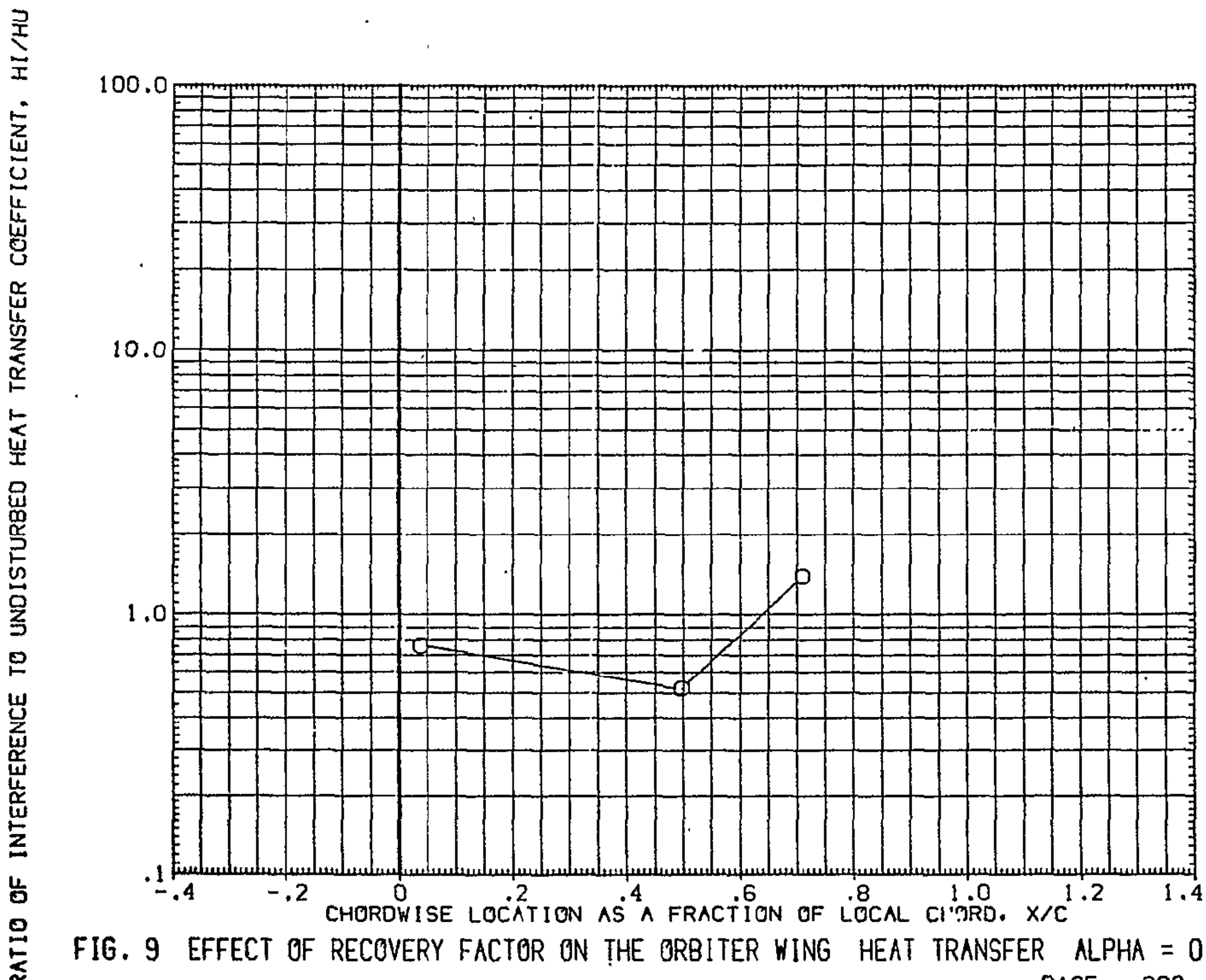

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH	PARAMETRIC VALUES			
O	.900	.600	7.610	ALPHA	.000	BETA	.000

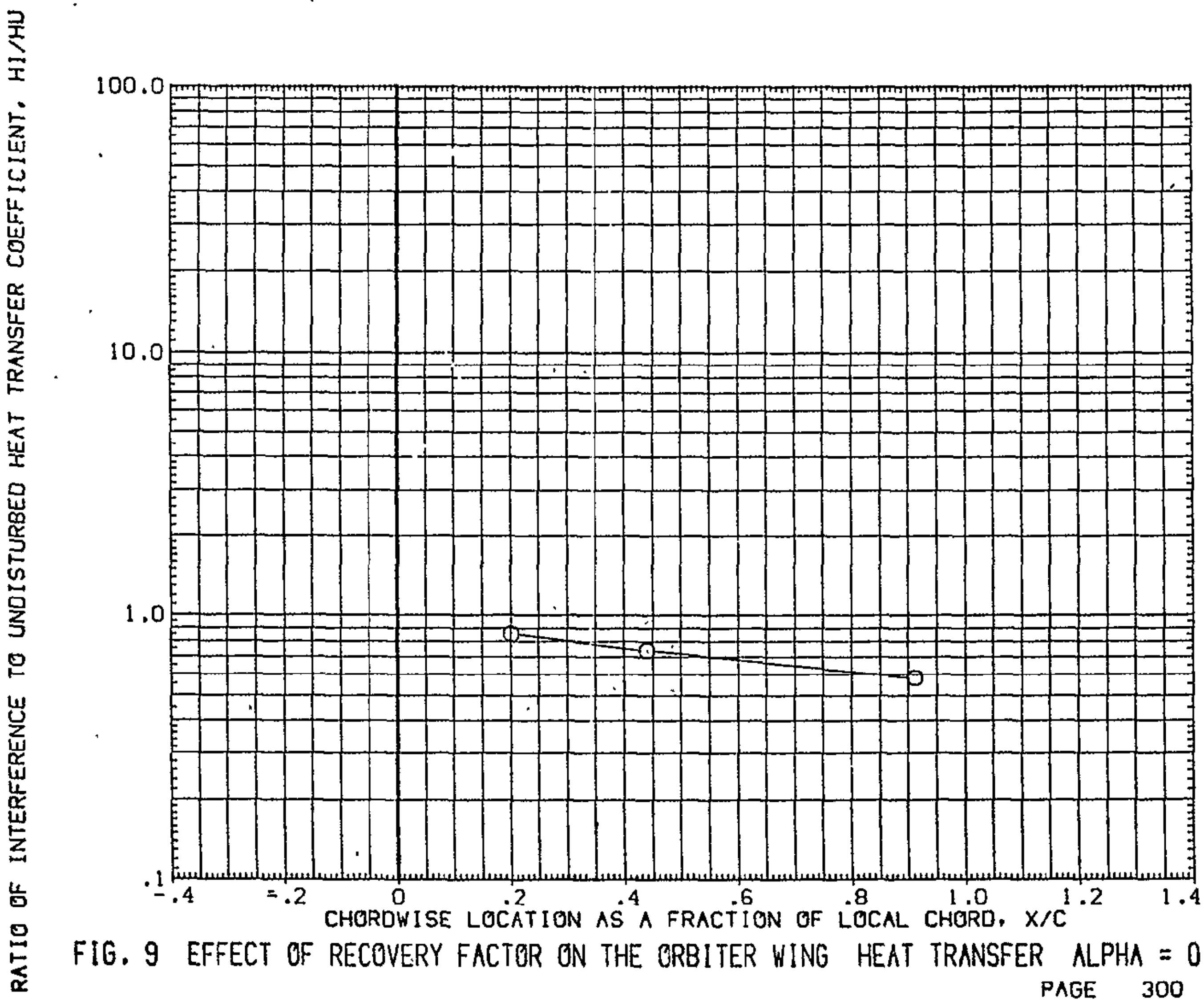

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

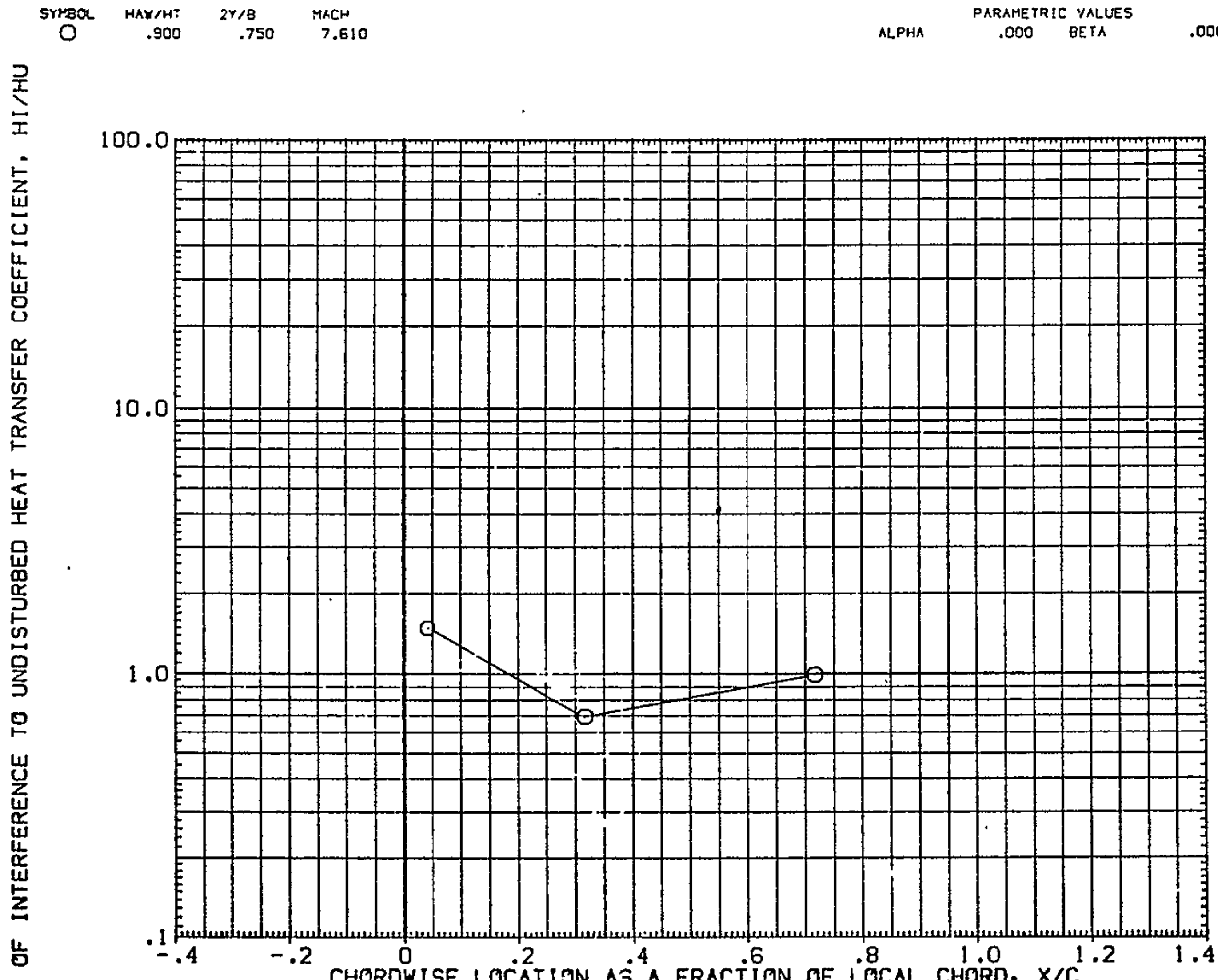

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

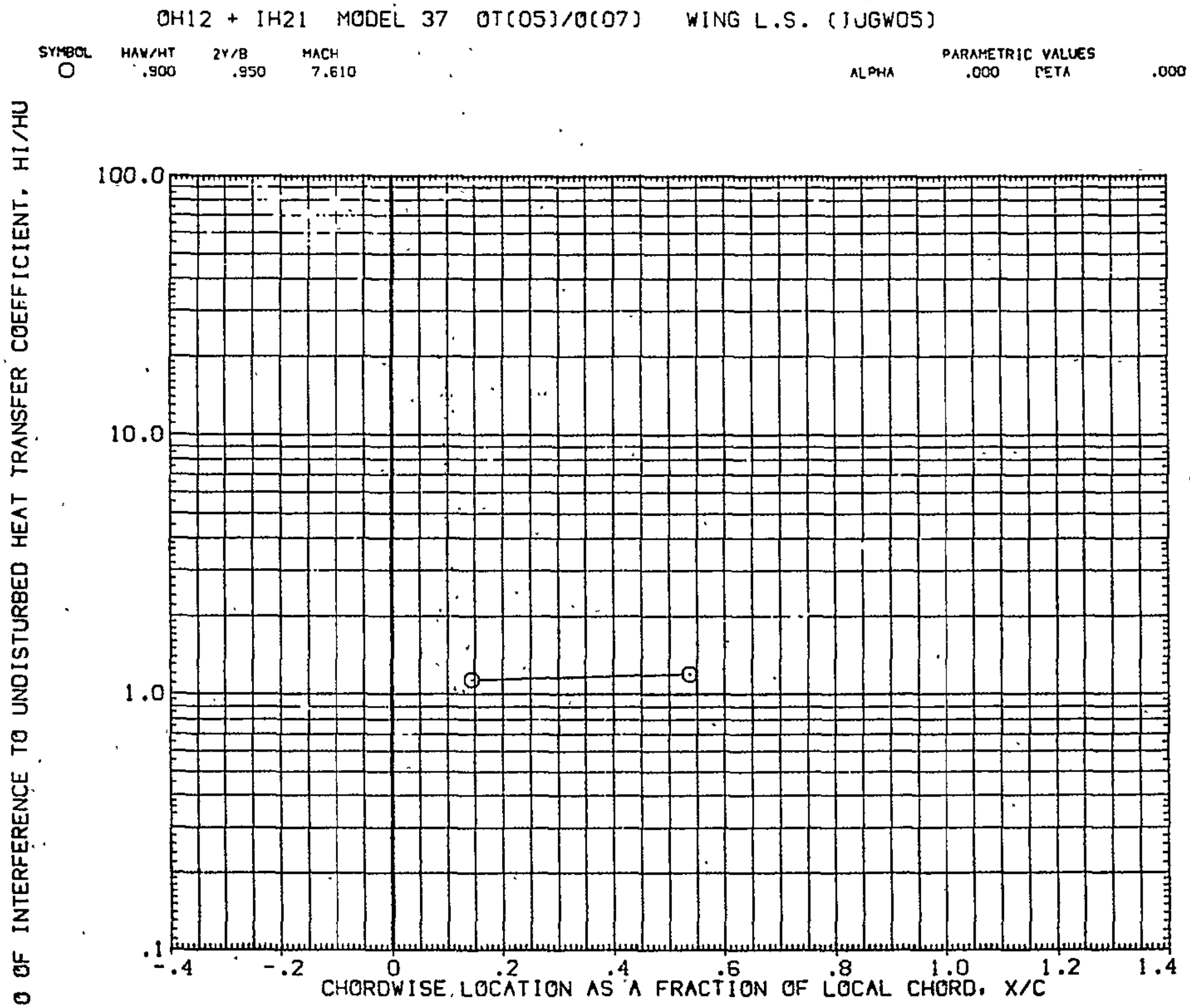

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

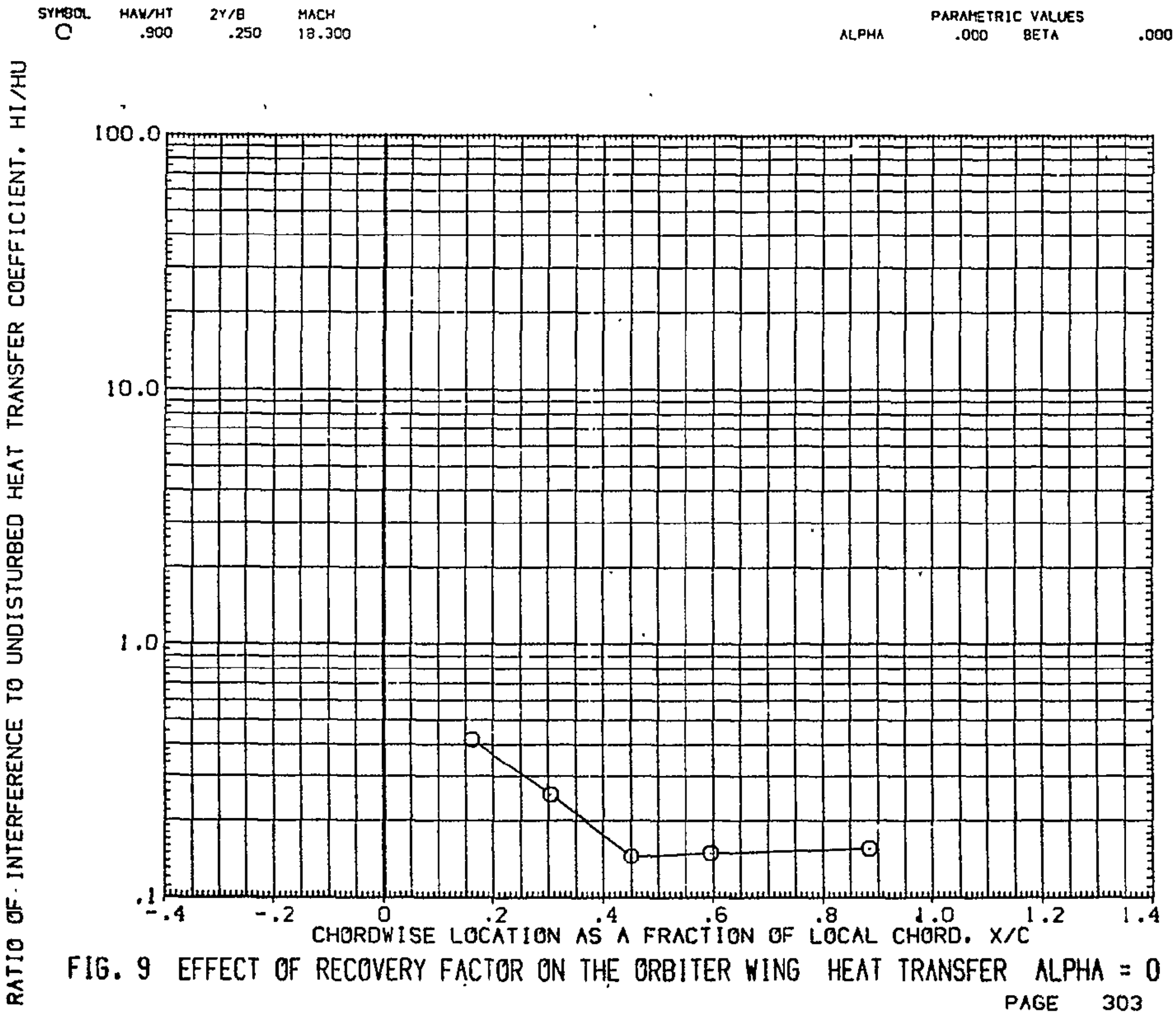

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

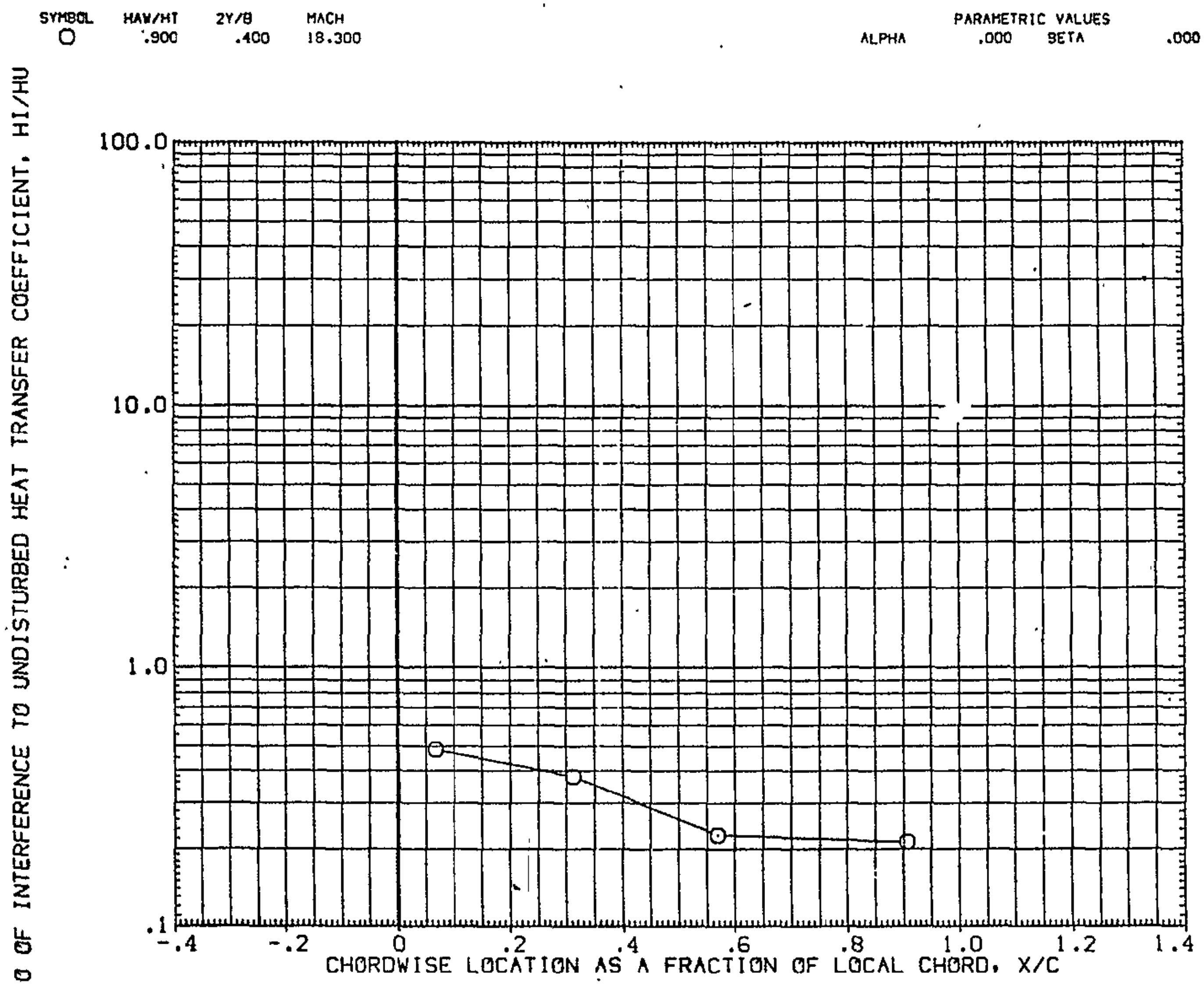

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

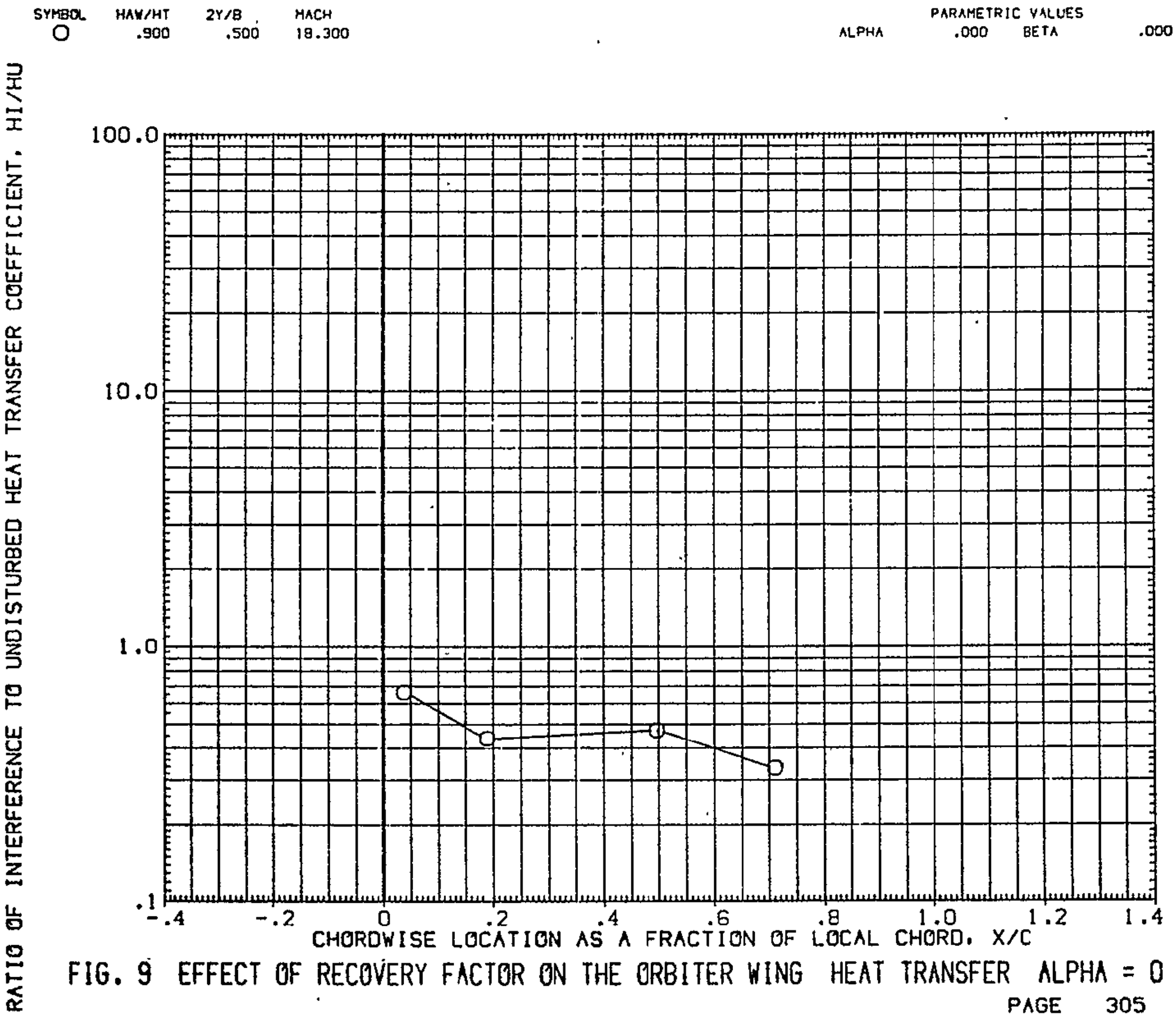

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.600	18.300

PARAMETRIC VALUES

ALPHA .000 BETA .000

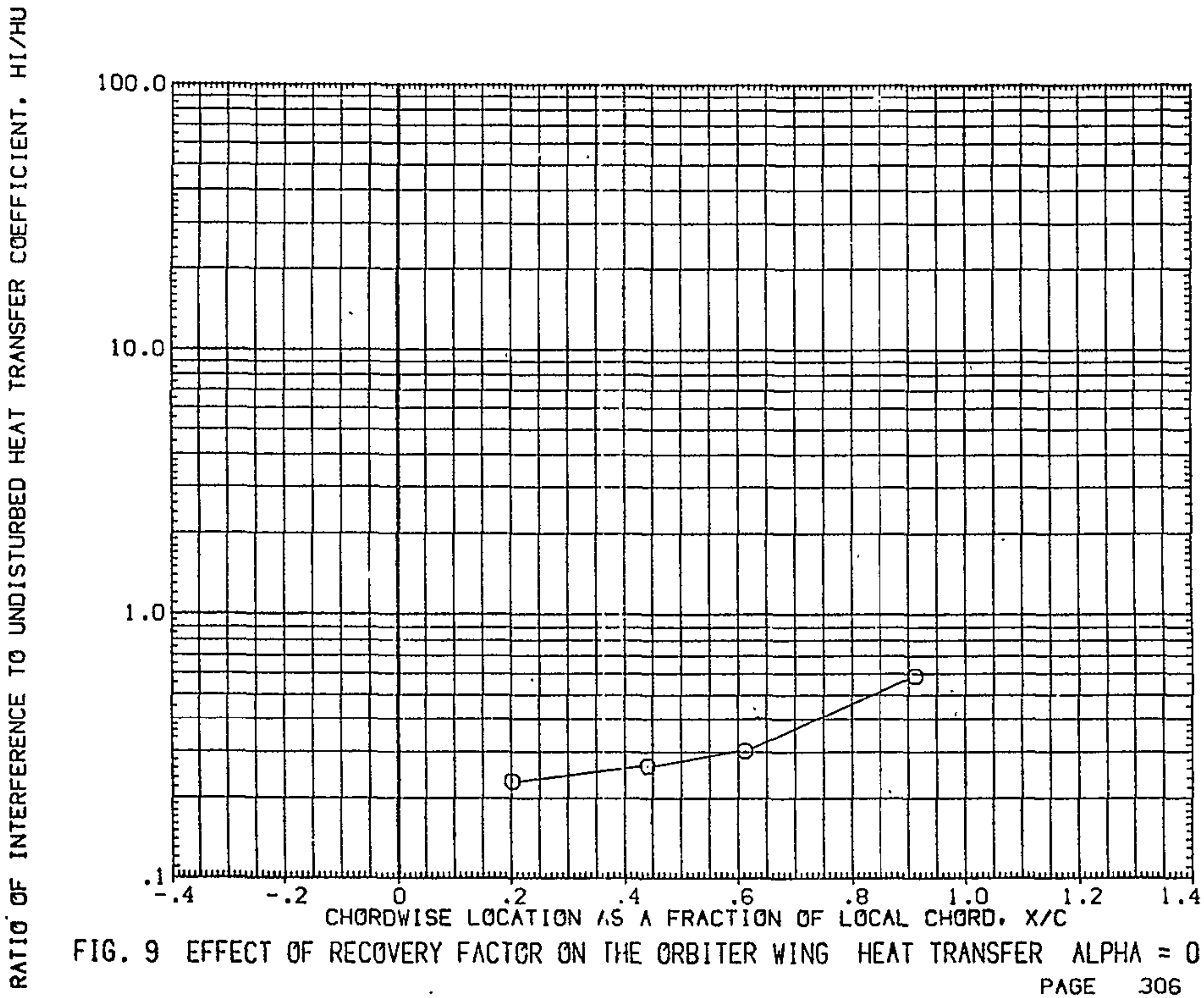

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH	PAPAMETRIC VALUES			
O	.900	.750	18.300	ALPHA	.000	BETA	.000

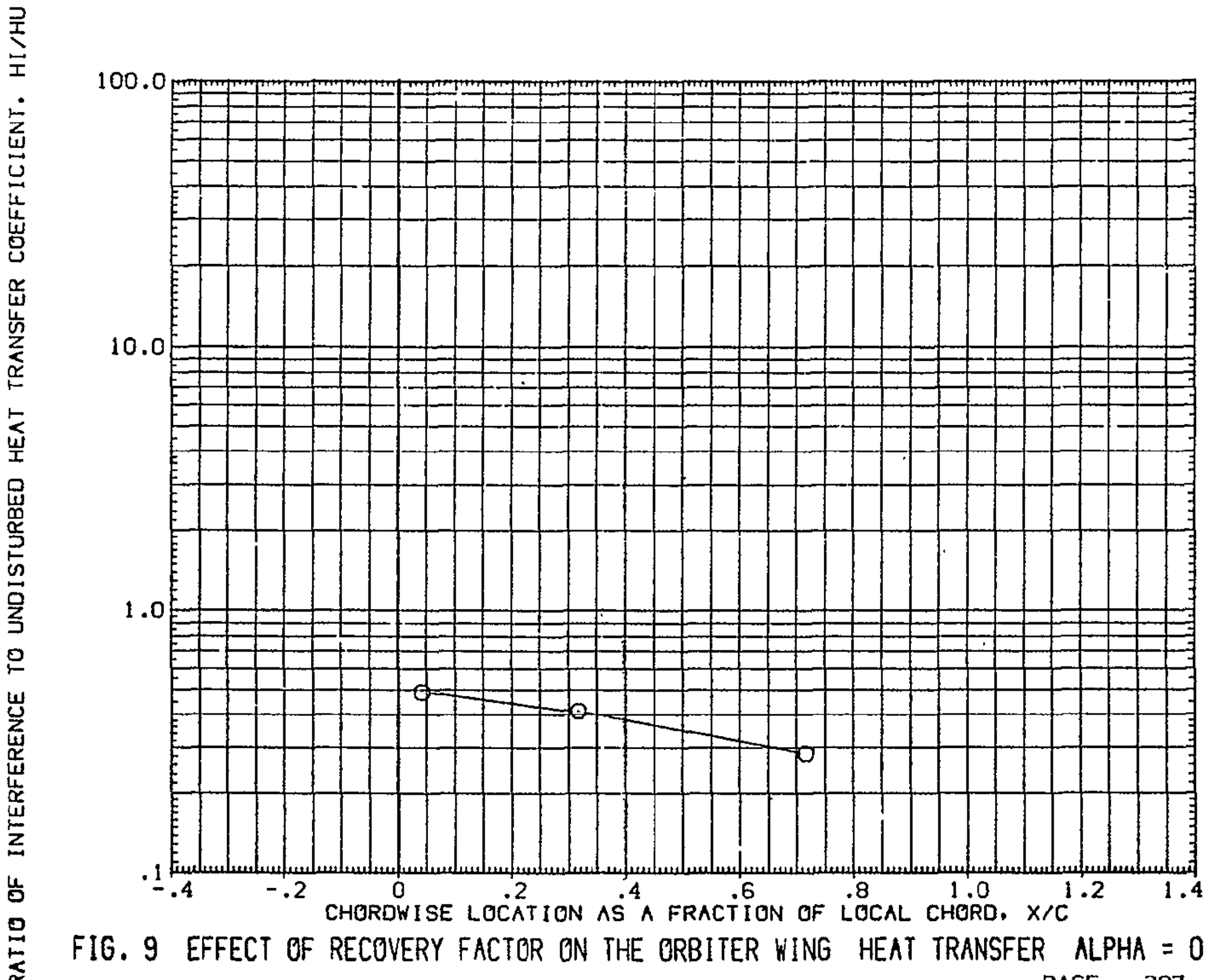

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OHI2 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

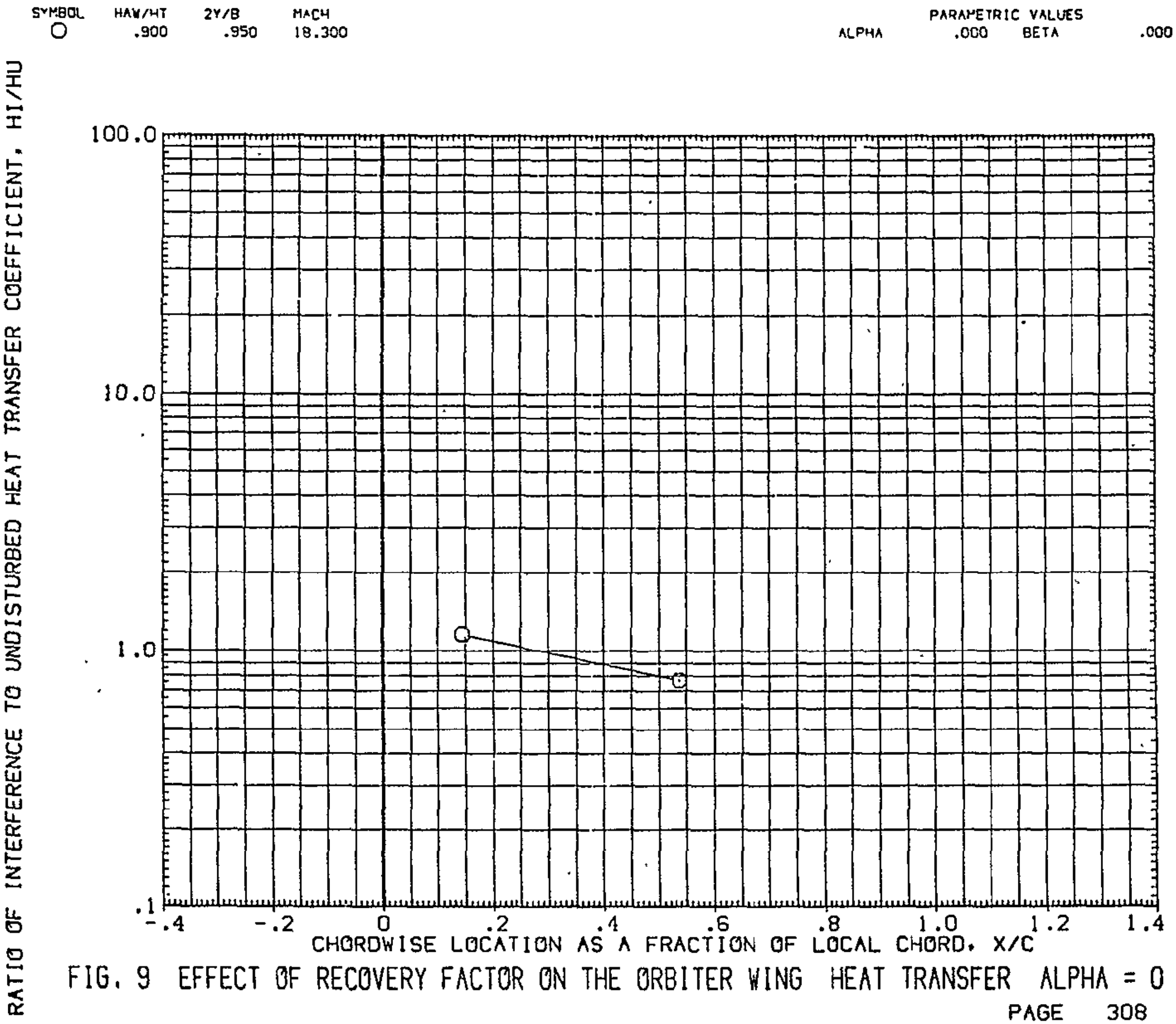

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

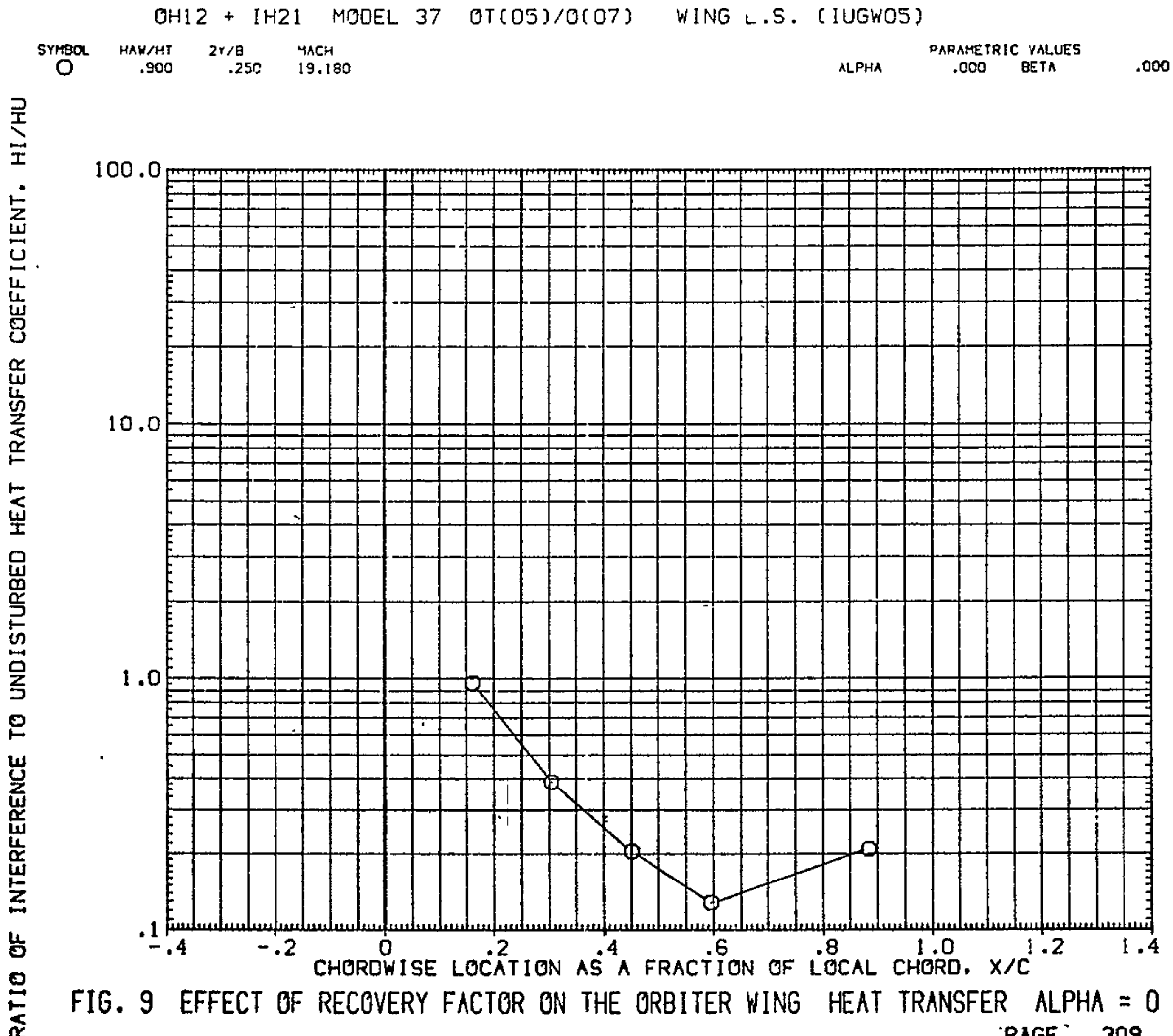

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 .MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.400	19.180

PARAMETRIC VALUES

ALPHA .000 BETA .000

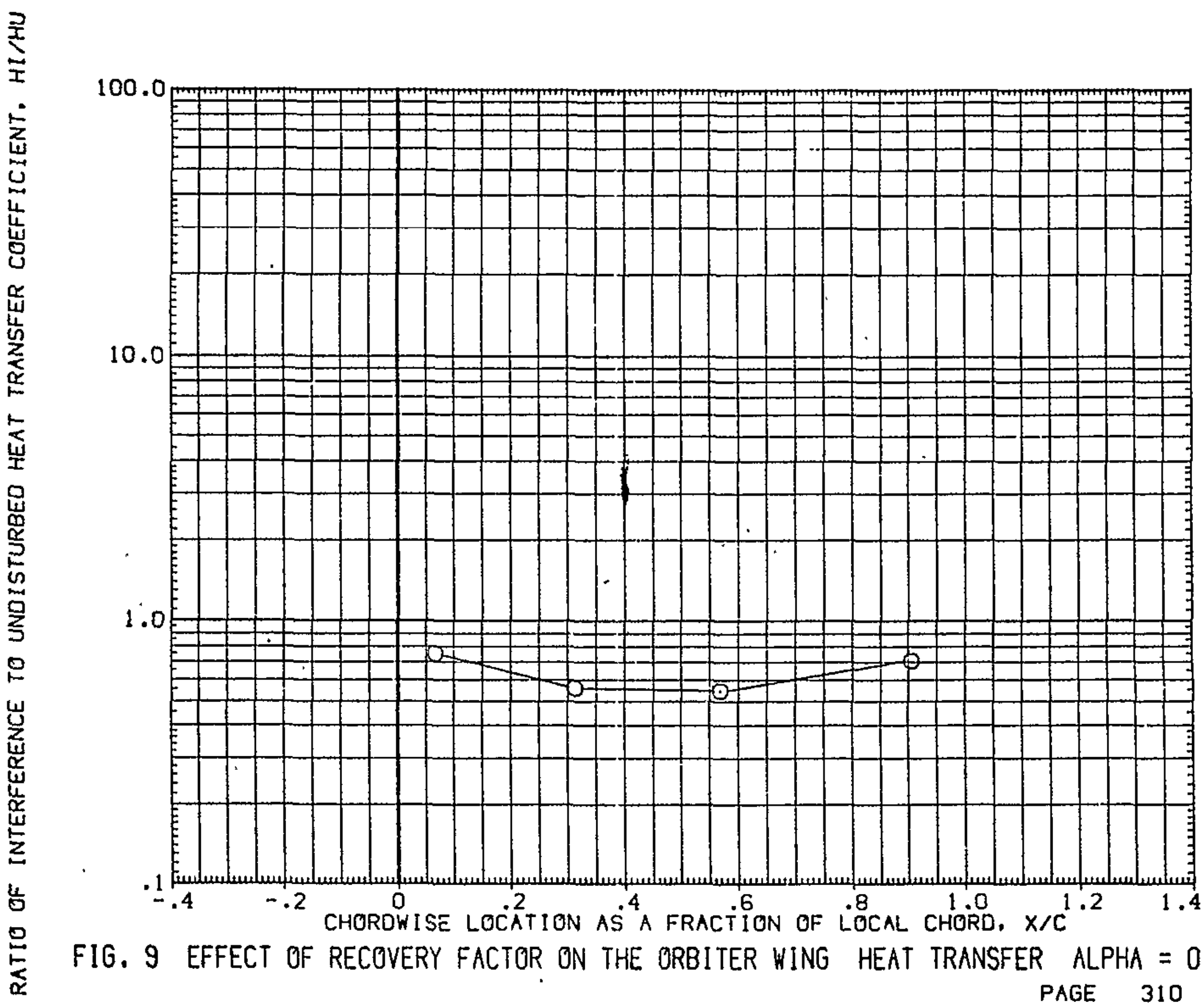

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

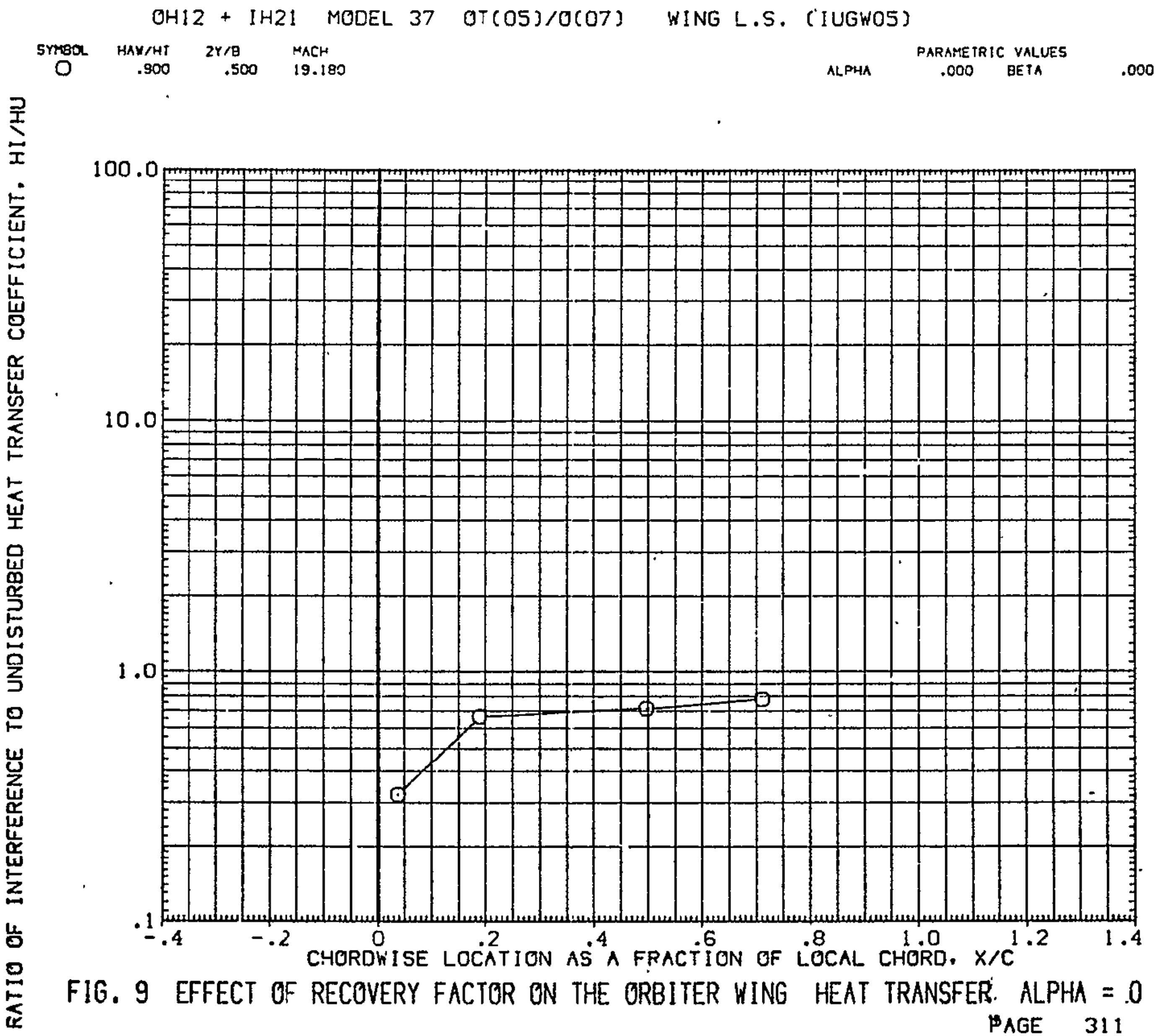

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = .0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH		PARAMETRIC VALUES		
O	.900	.600	19.180	ALPHA	.000	BETA	.000

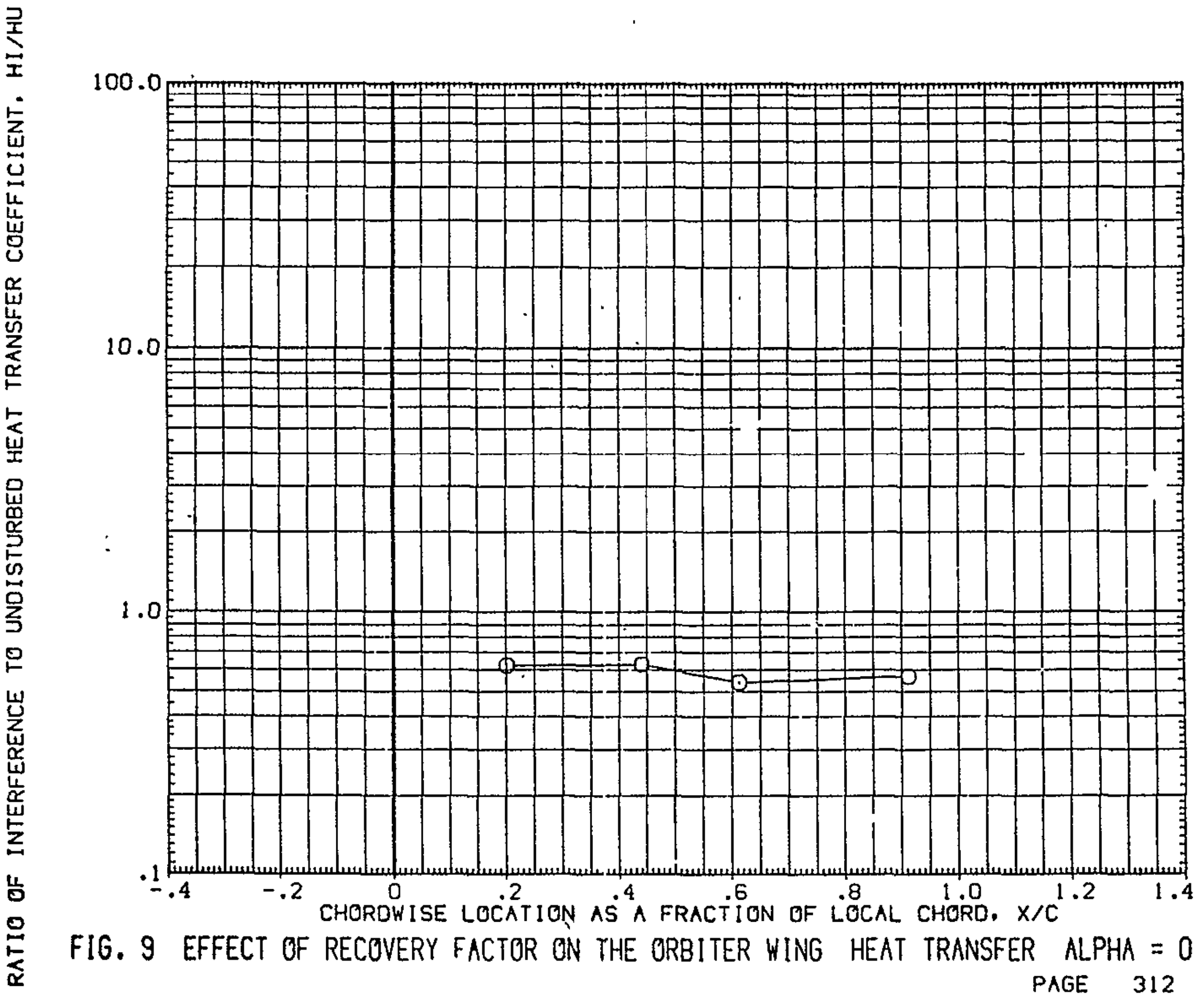

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 01(05)/0(07) WING L.S. (IUGW05)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.750	19.180

PARAMETRIC VALUES
ALPHA .000 BETA .000

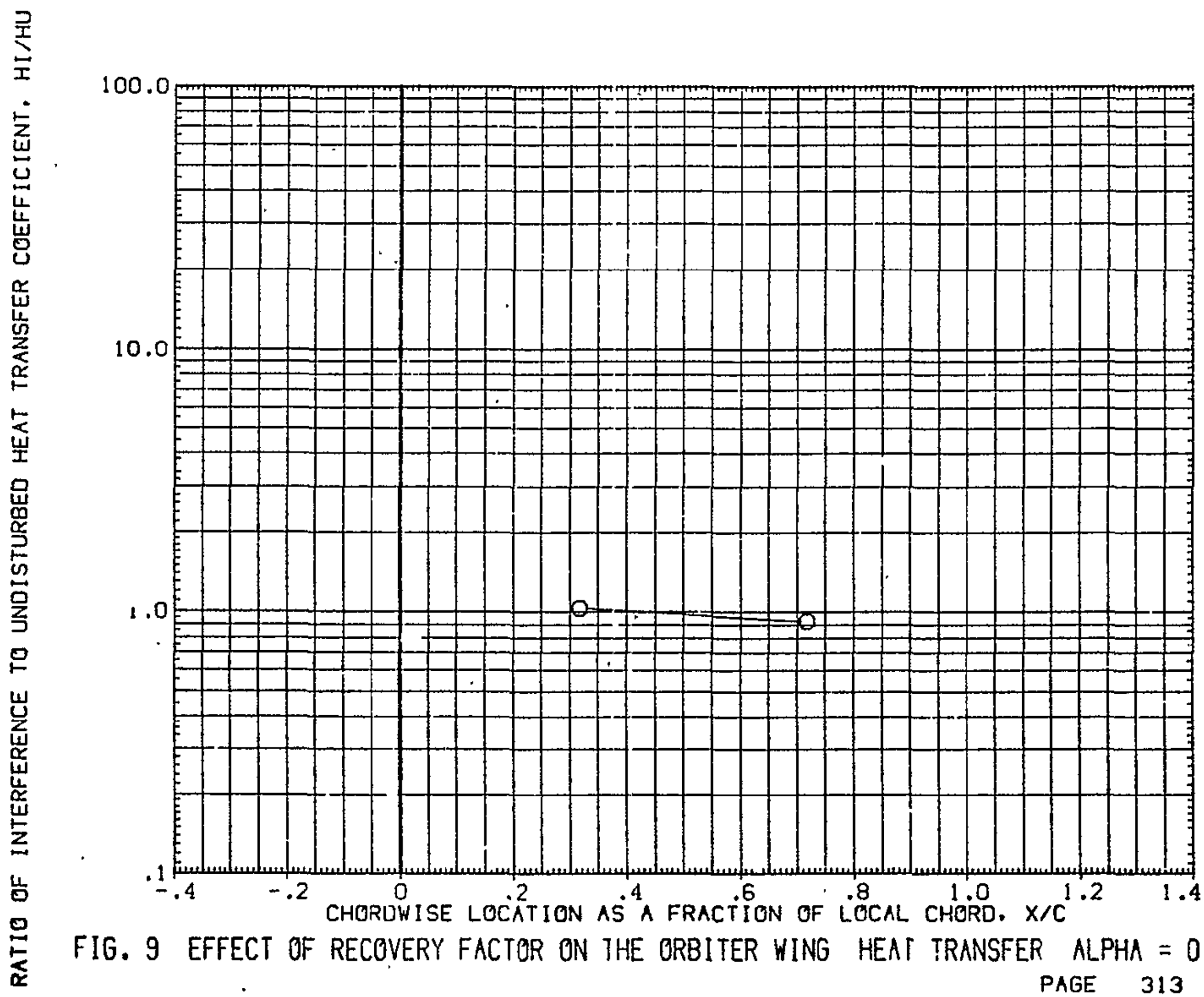

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) WING L.S. (IUGW05)

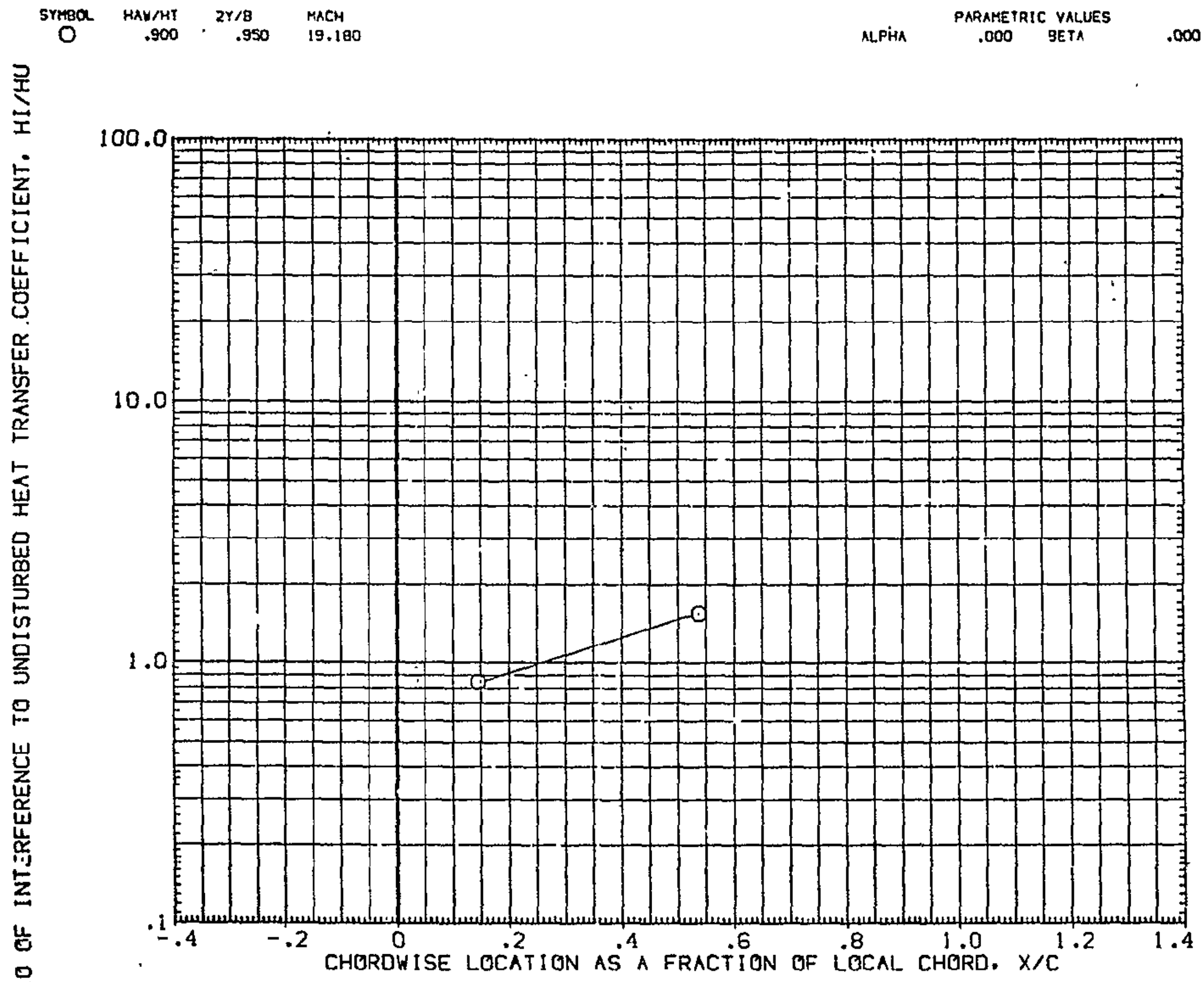

FIG. 9 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 VERTICAL (RUGV07)

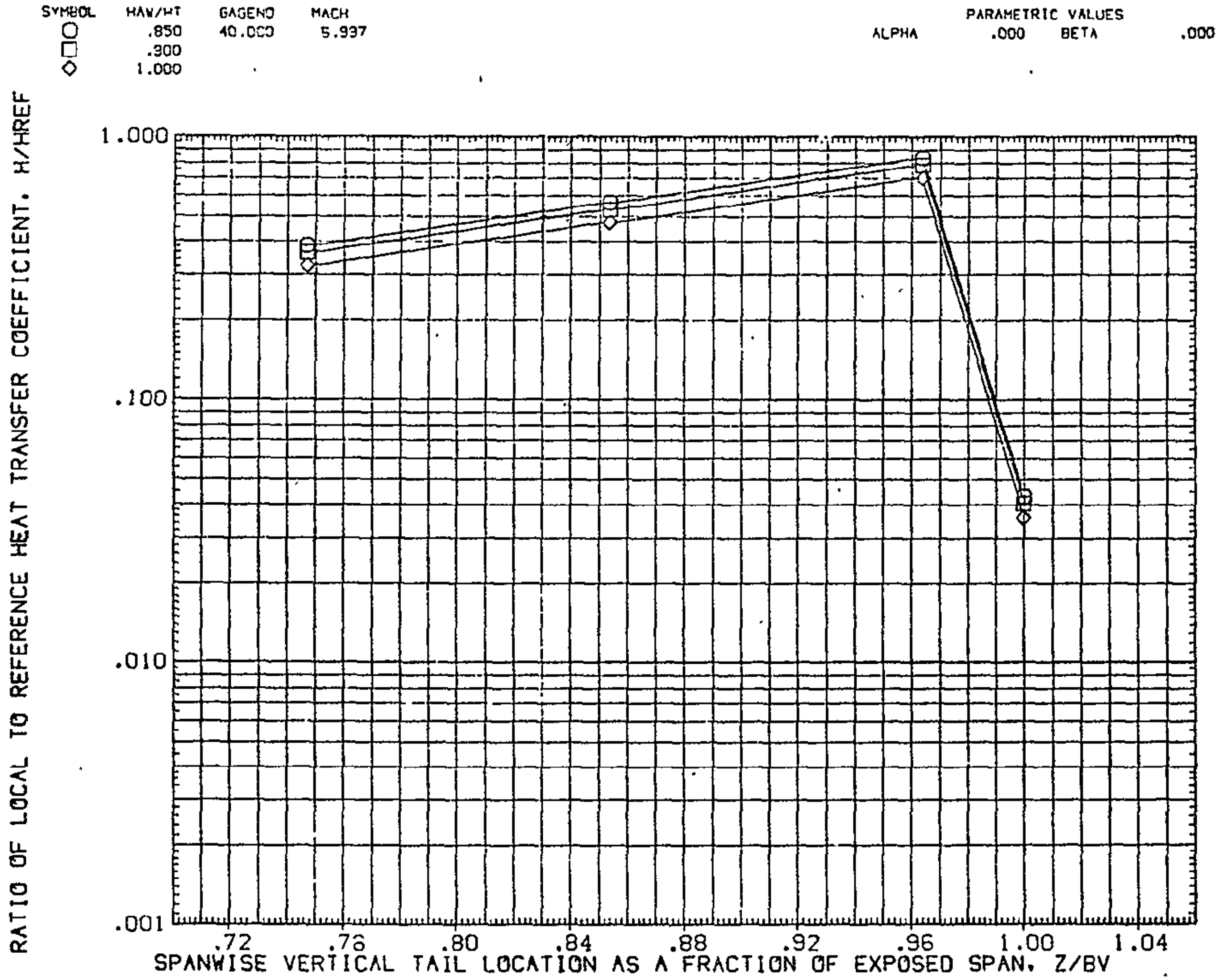

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

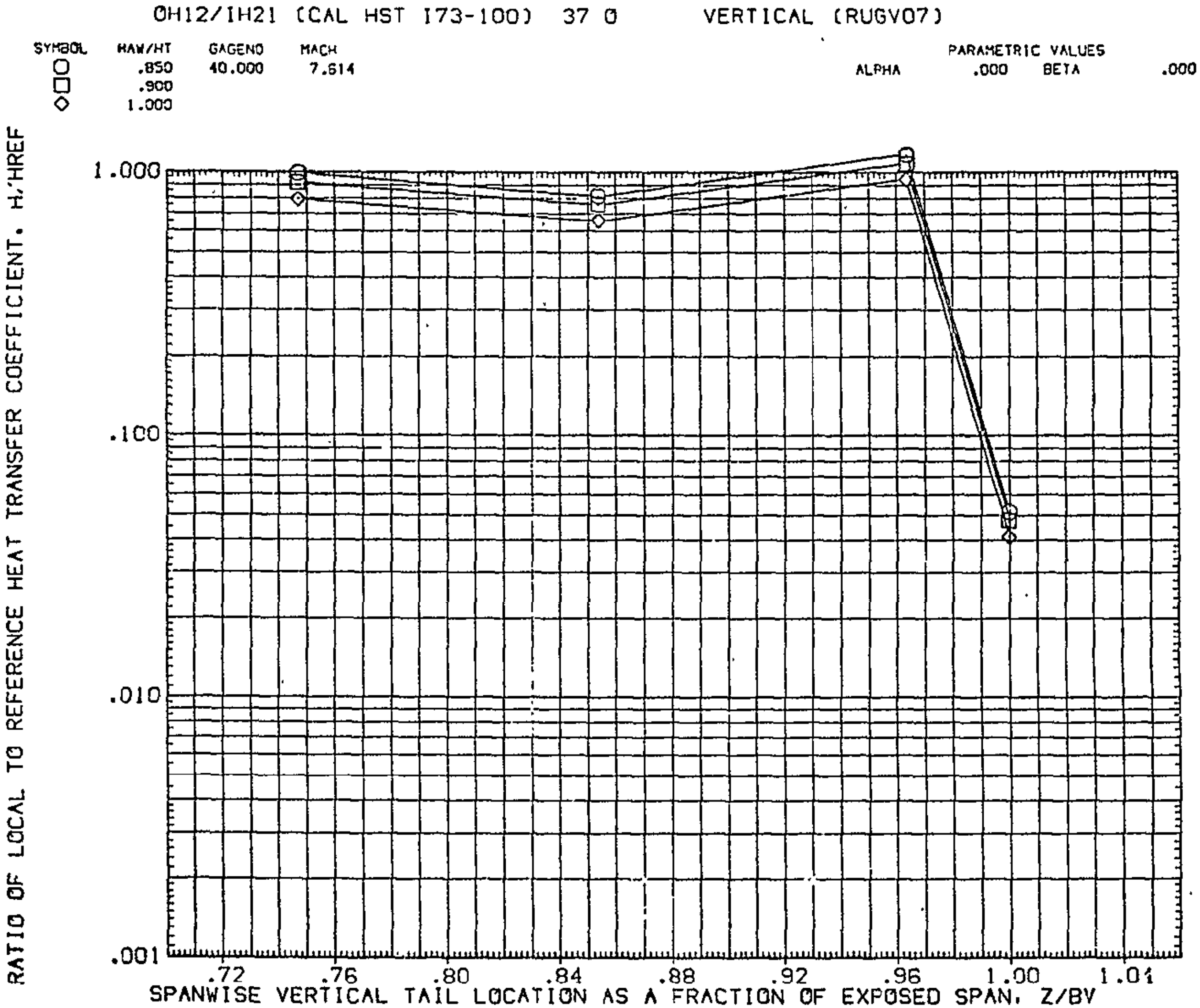

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

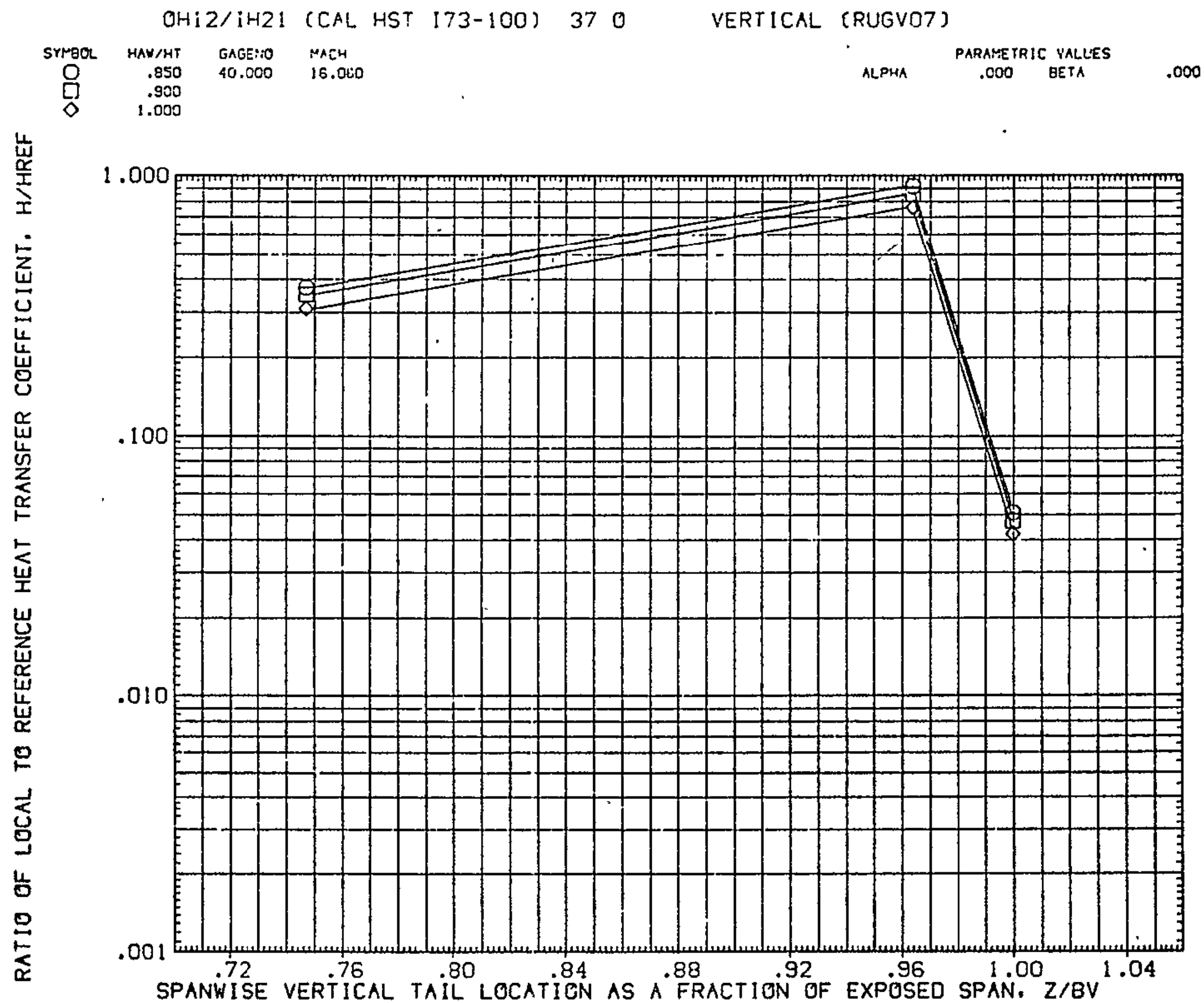

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

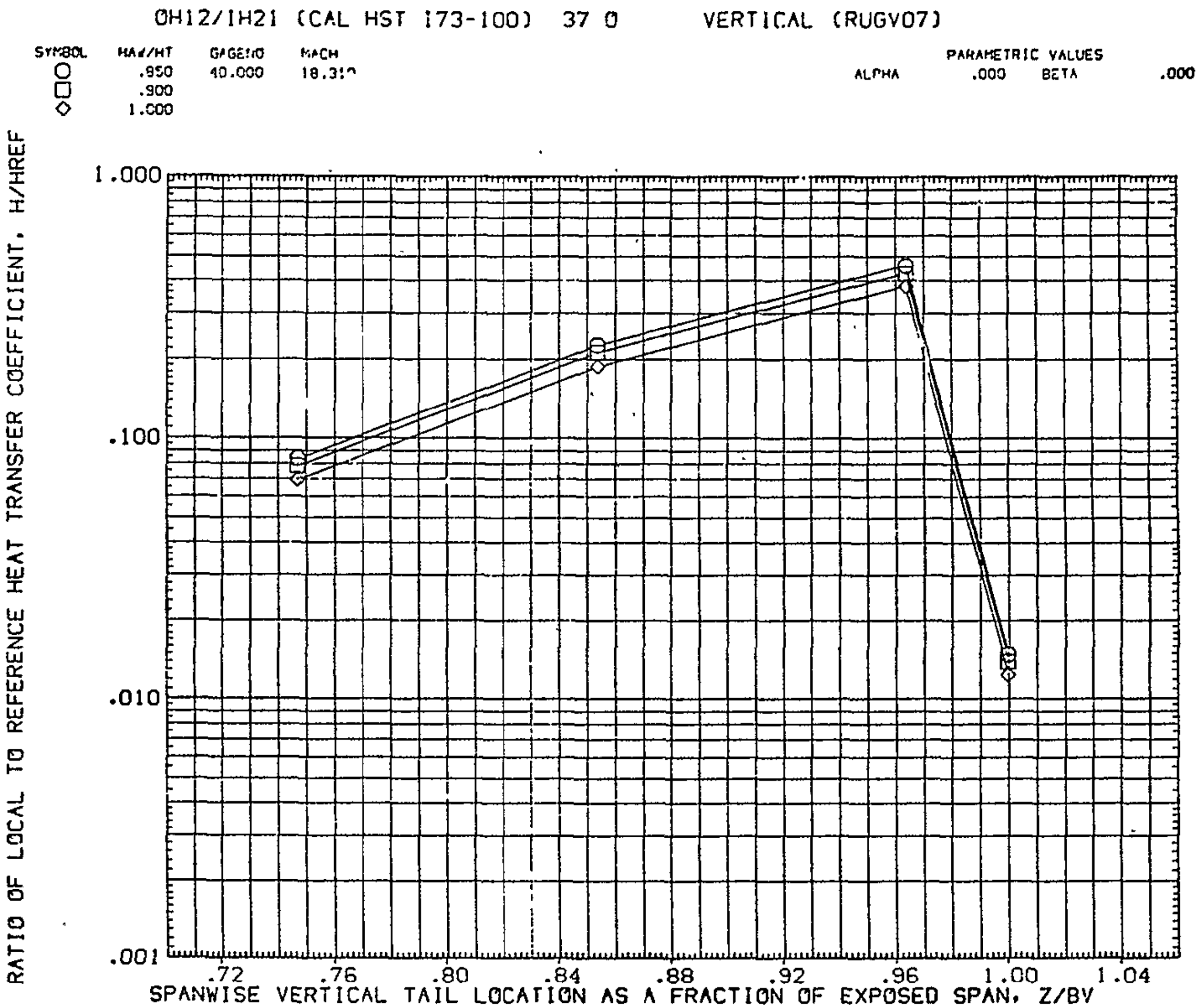

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

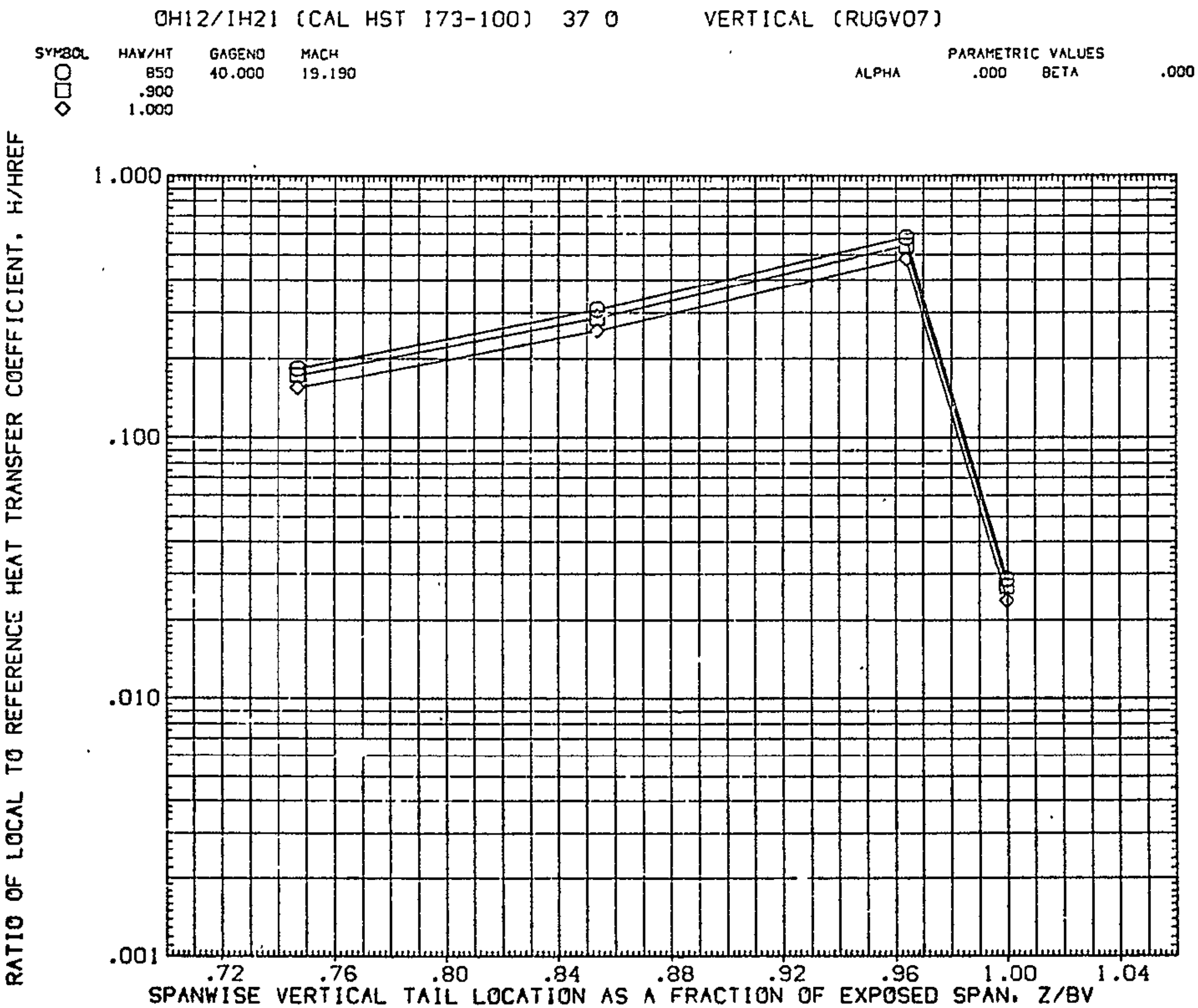

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

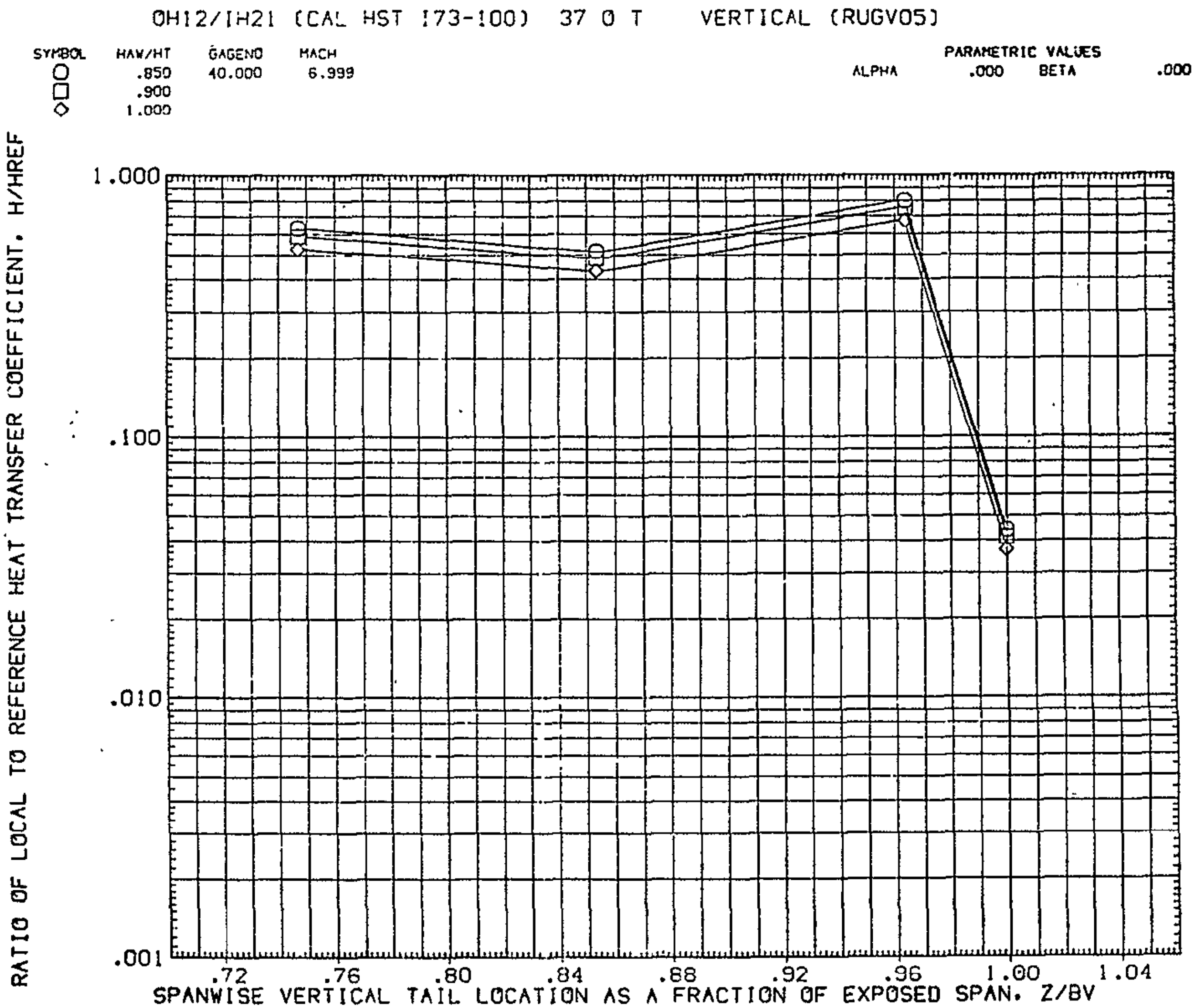

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

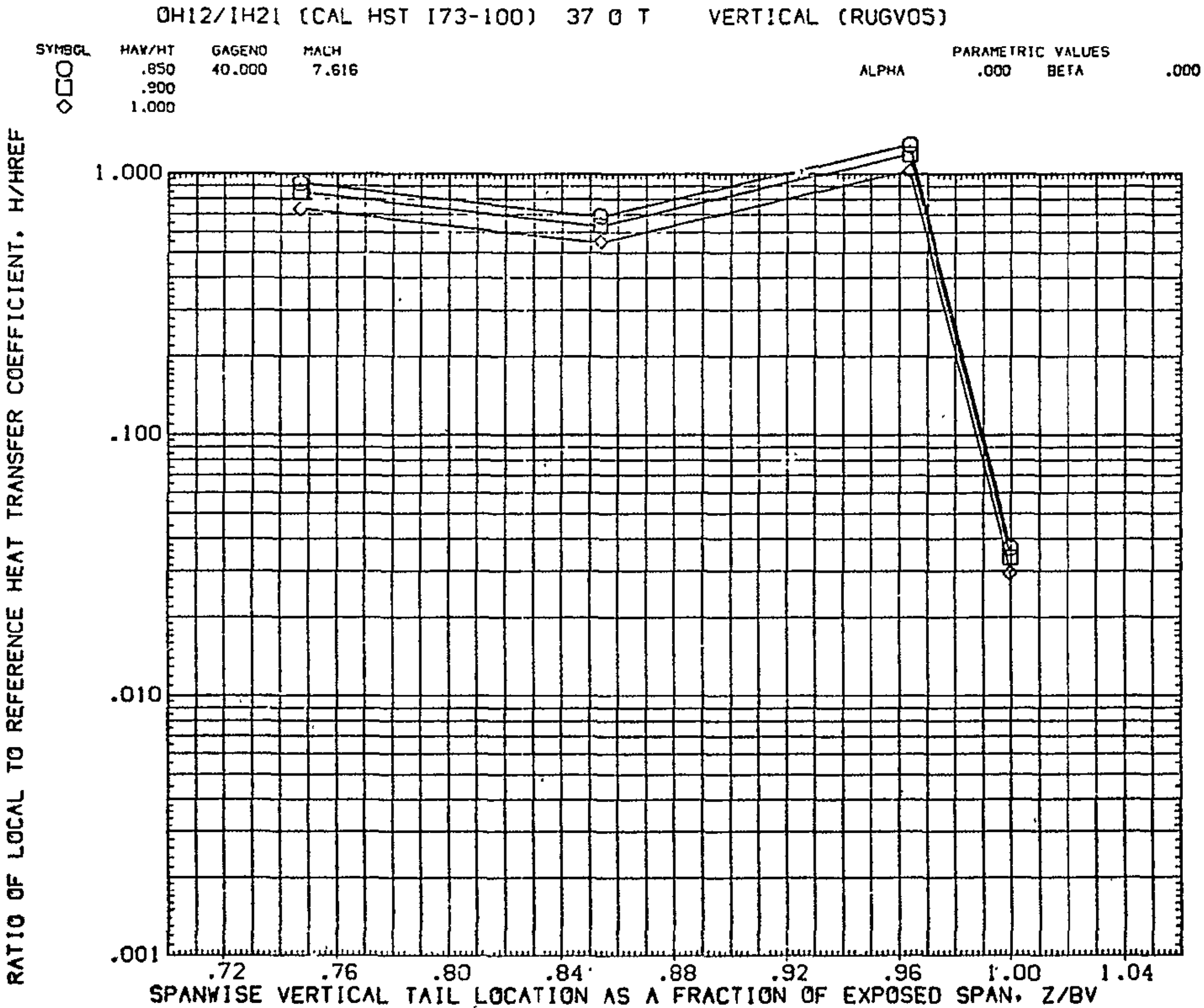

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

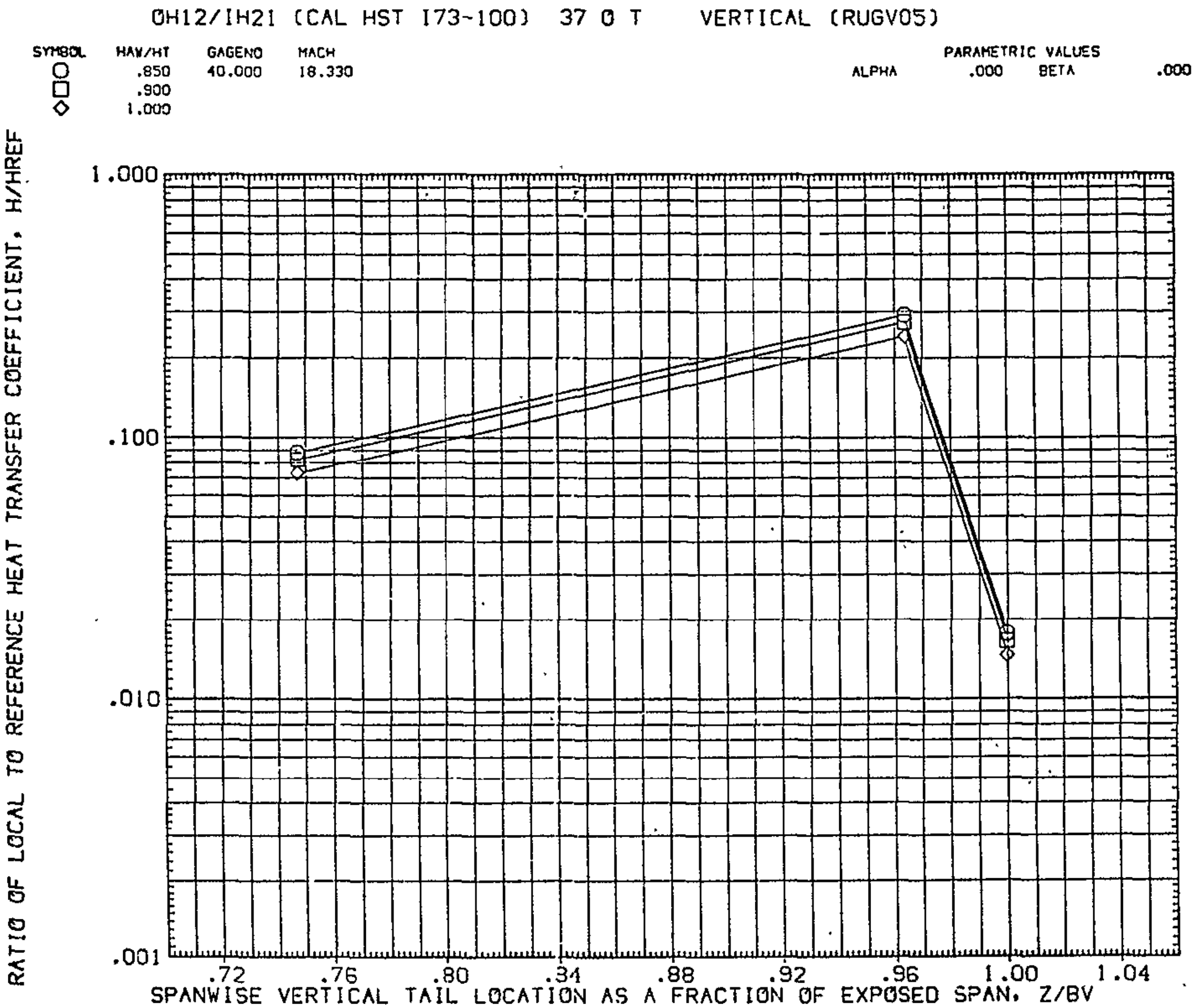

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T VERTICAL (RUGV05)

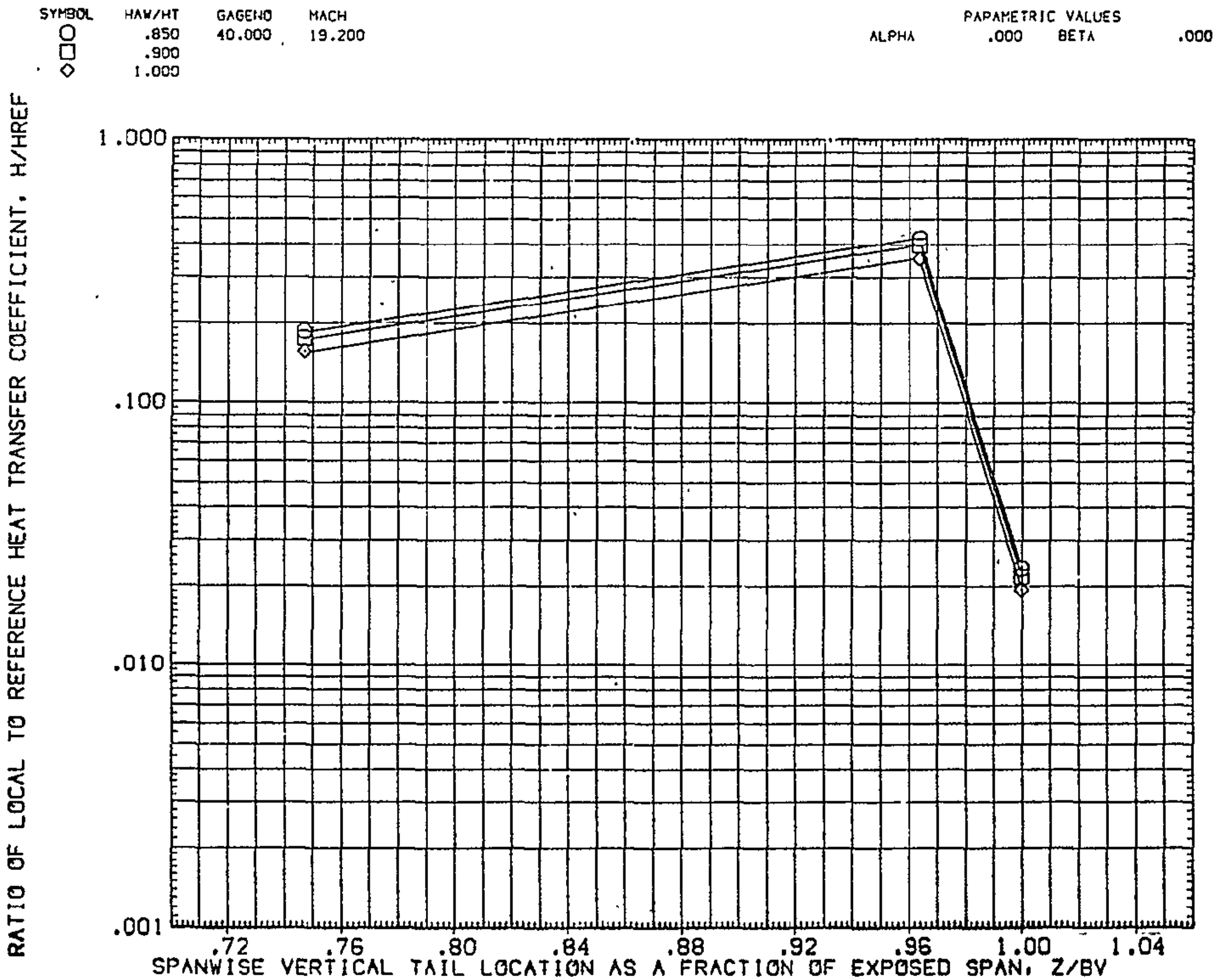

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) VERTICAL (IUGV05)

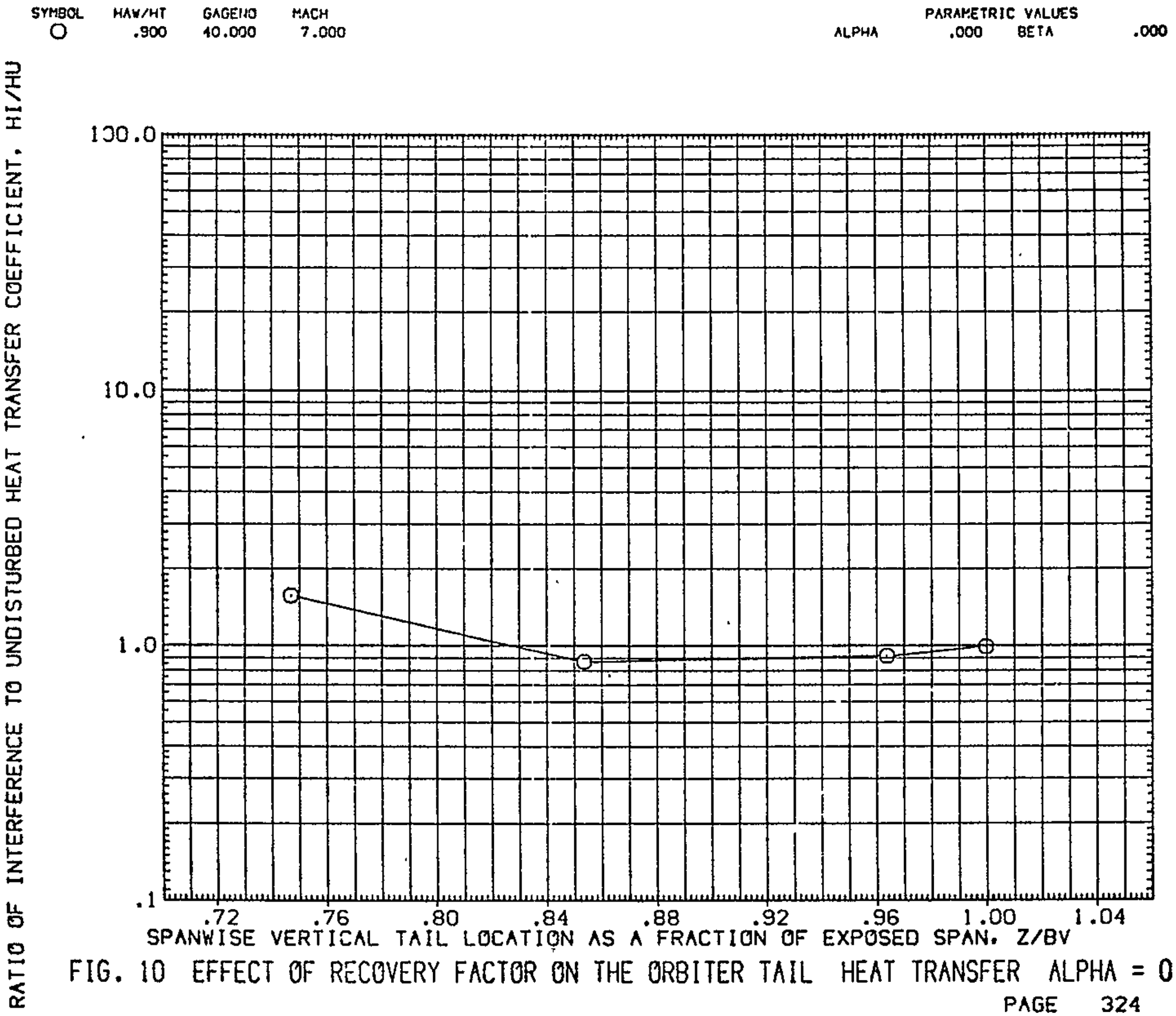

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

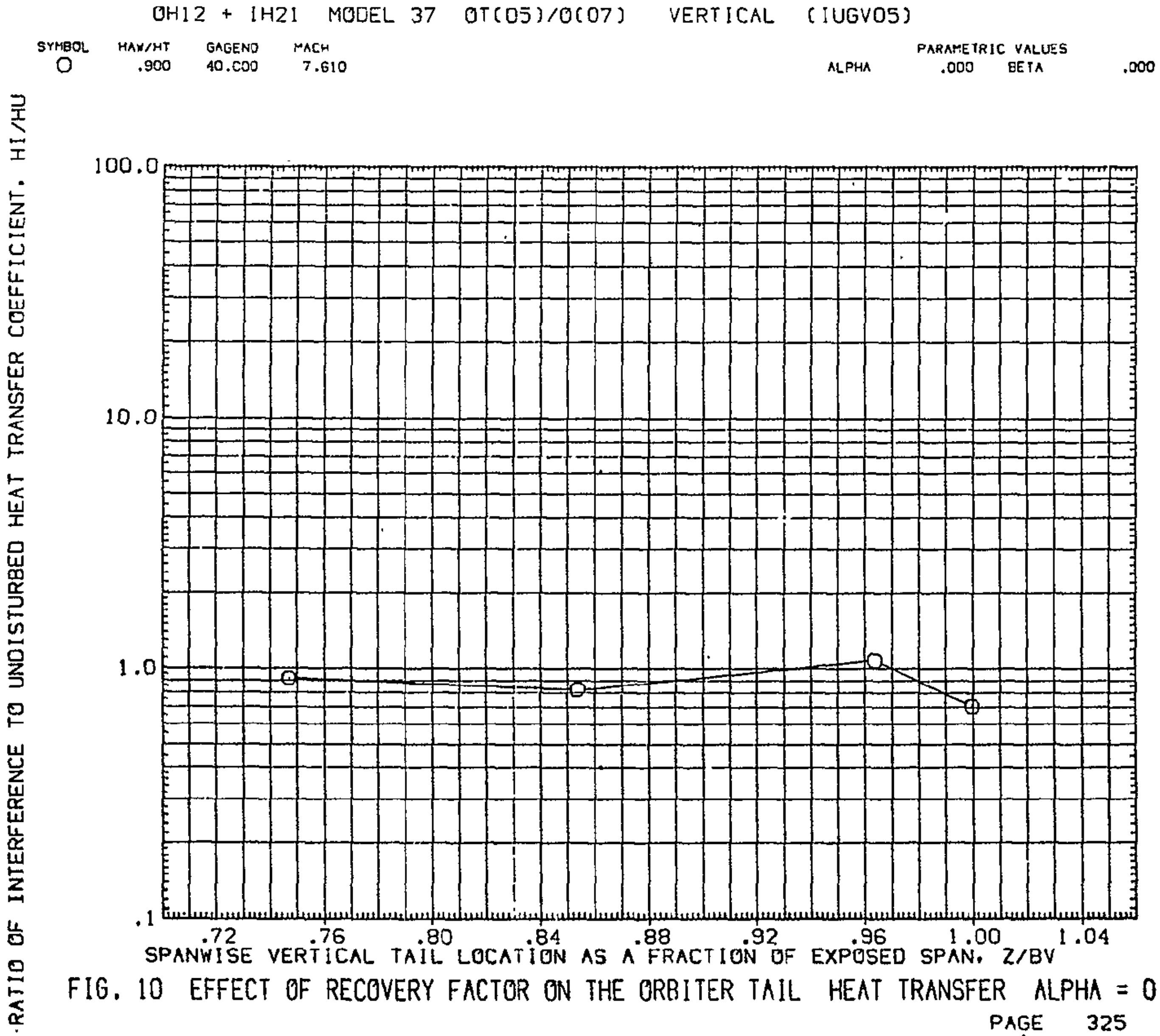

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

OH12 + IH21 MODEL 37 OT(05)/O(07) VERTICAL (IUGV05)

SYMBOL	HAW/HT	GAGENO	MACH
○	.900	40.000	18.300

PARAMETRIC VALUES
ALPHA .000 BETA .000

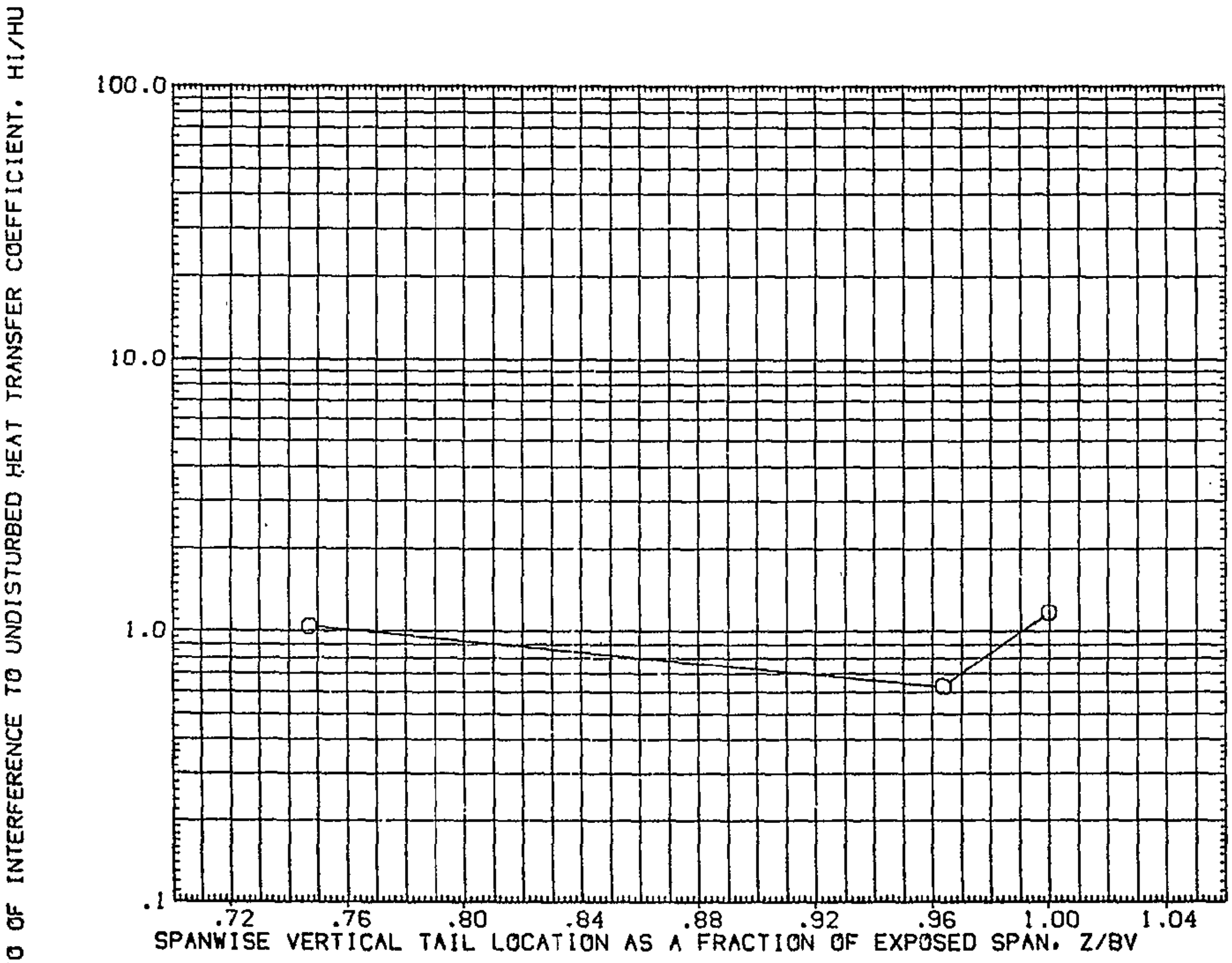

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

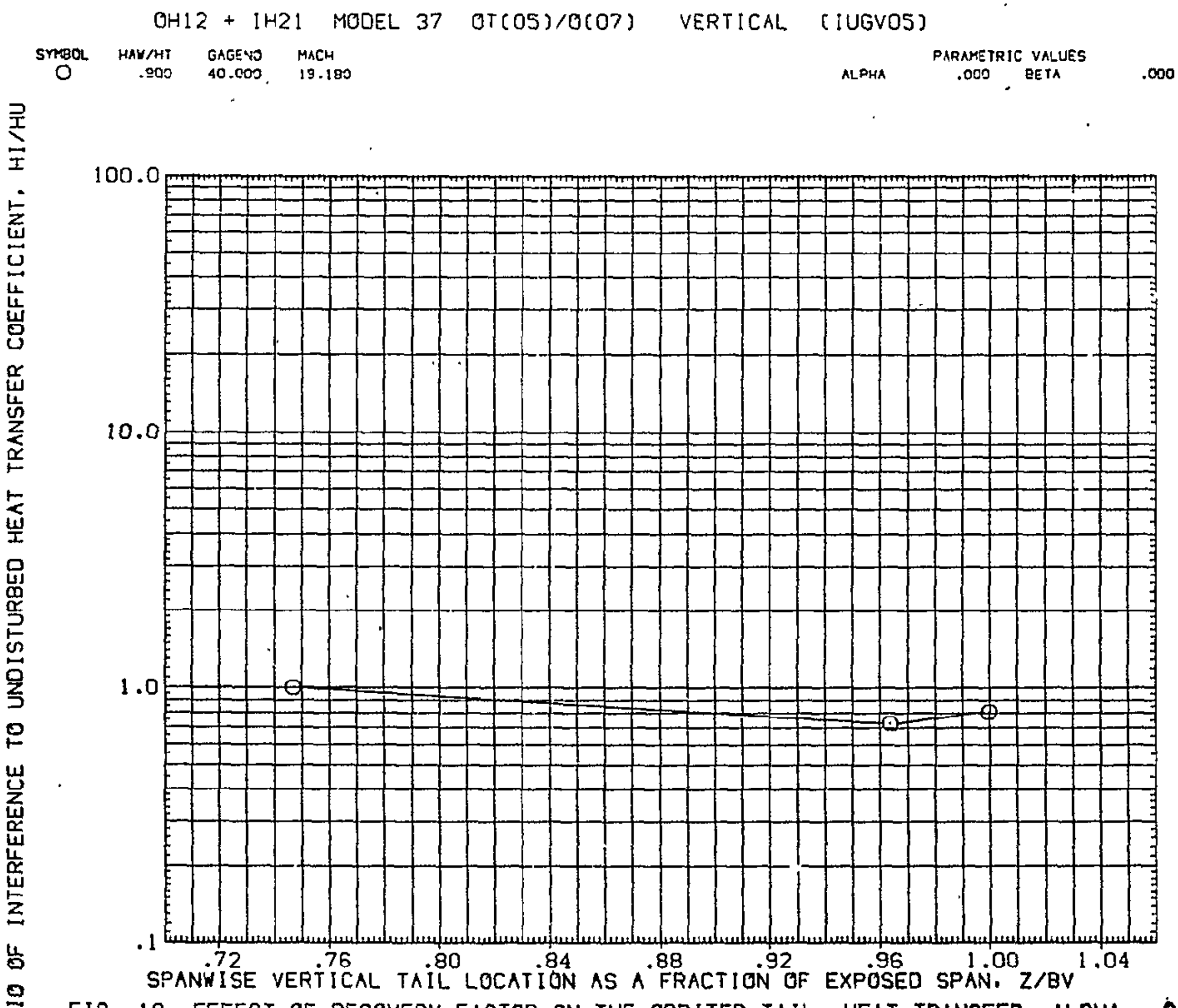

FIG. 10 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB08)

SYMBOL	HAW/HT	PHI	MACH
○	.850	.000	19.180
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

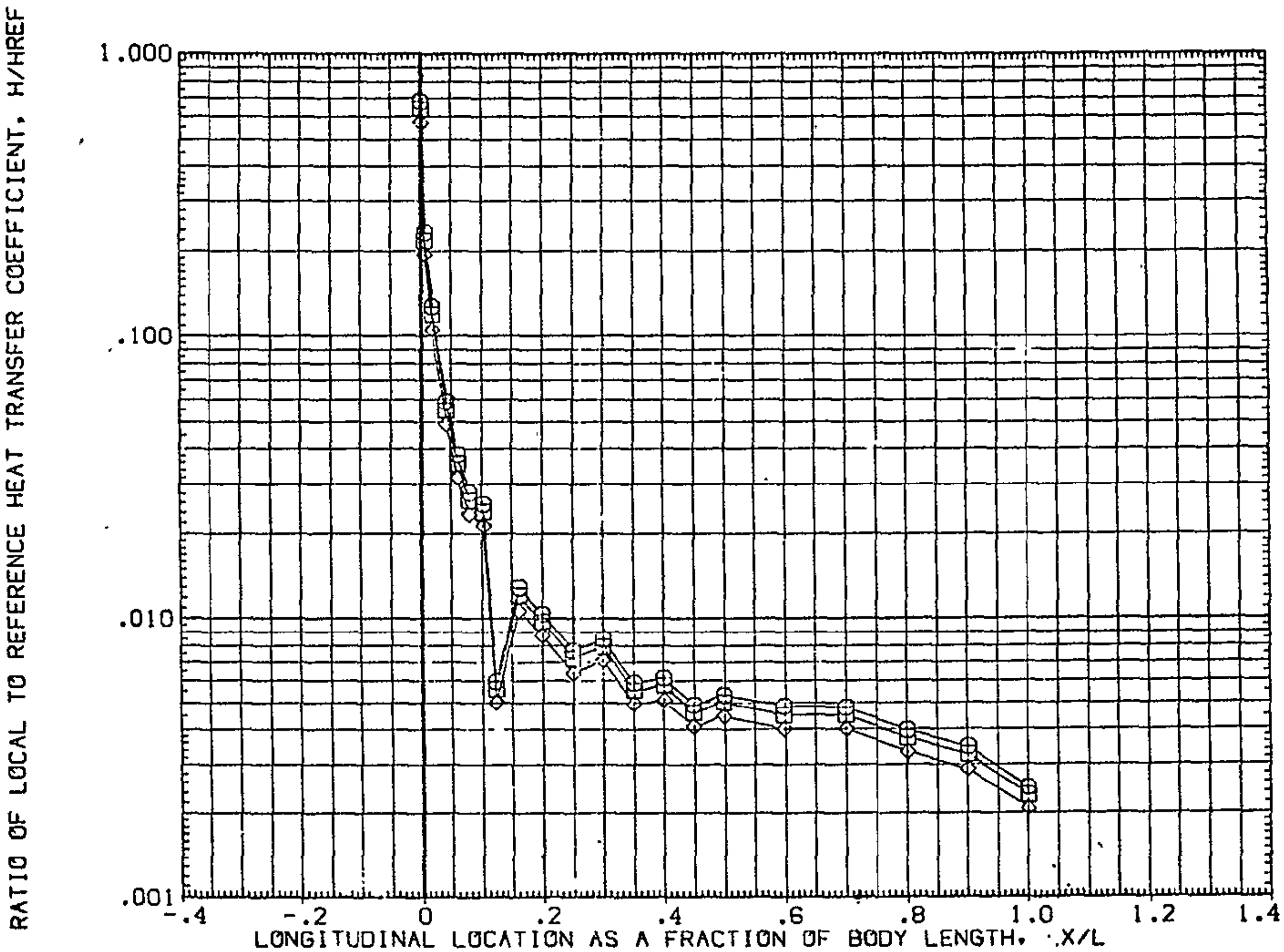

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB08)

SYMBOL	HAW/HT	PHI	MACH
○	.850	25.000	19.180
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

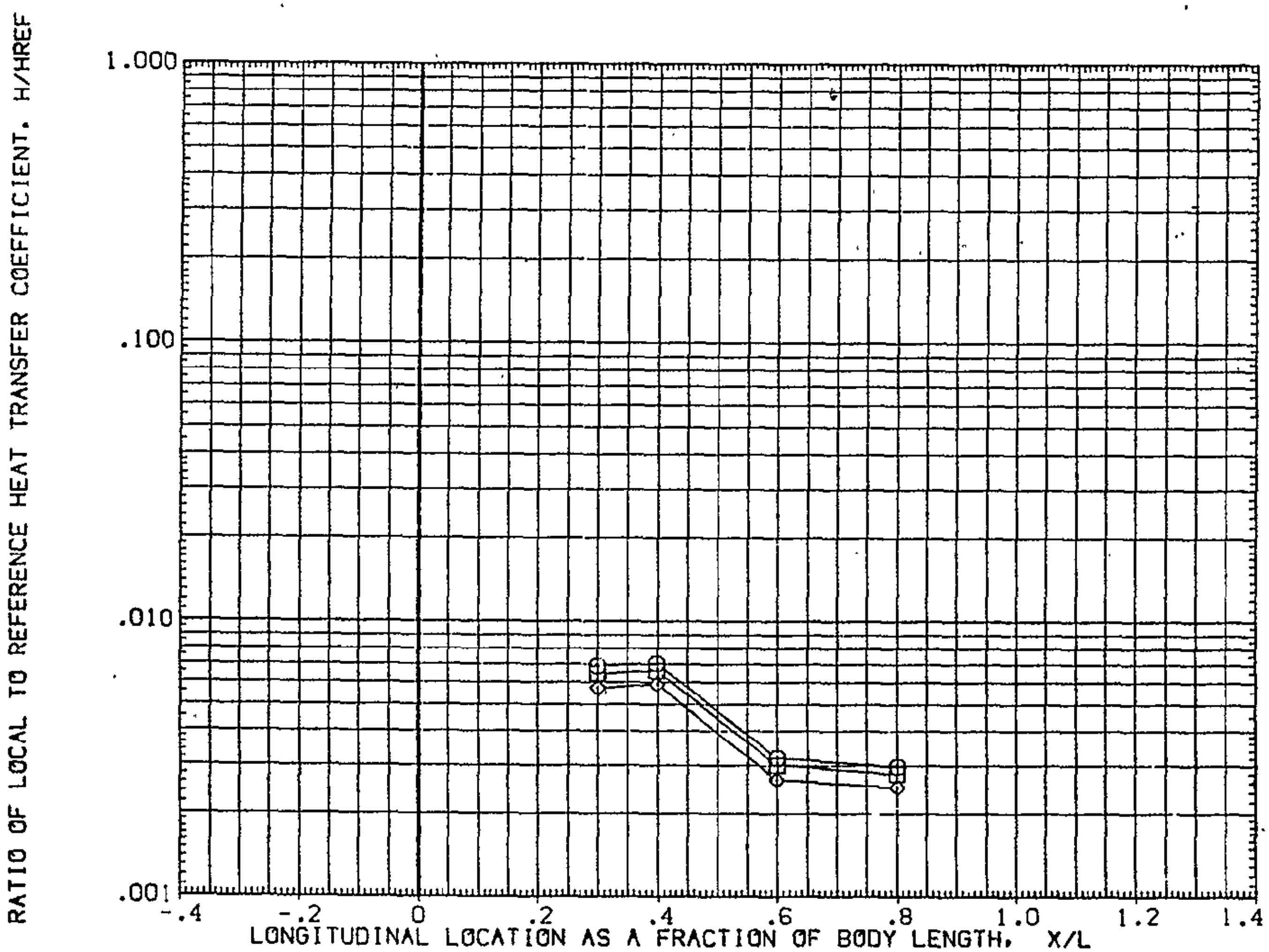

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 FUSELAGE (RUGB08)

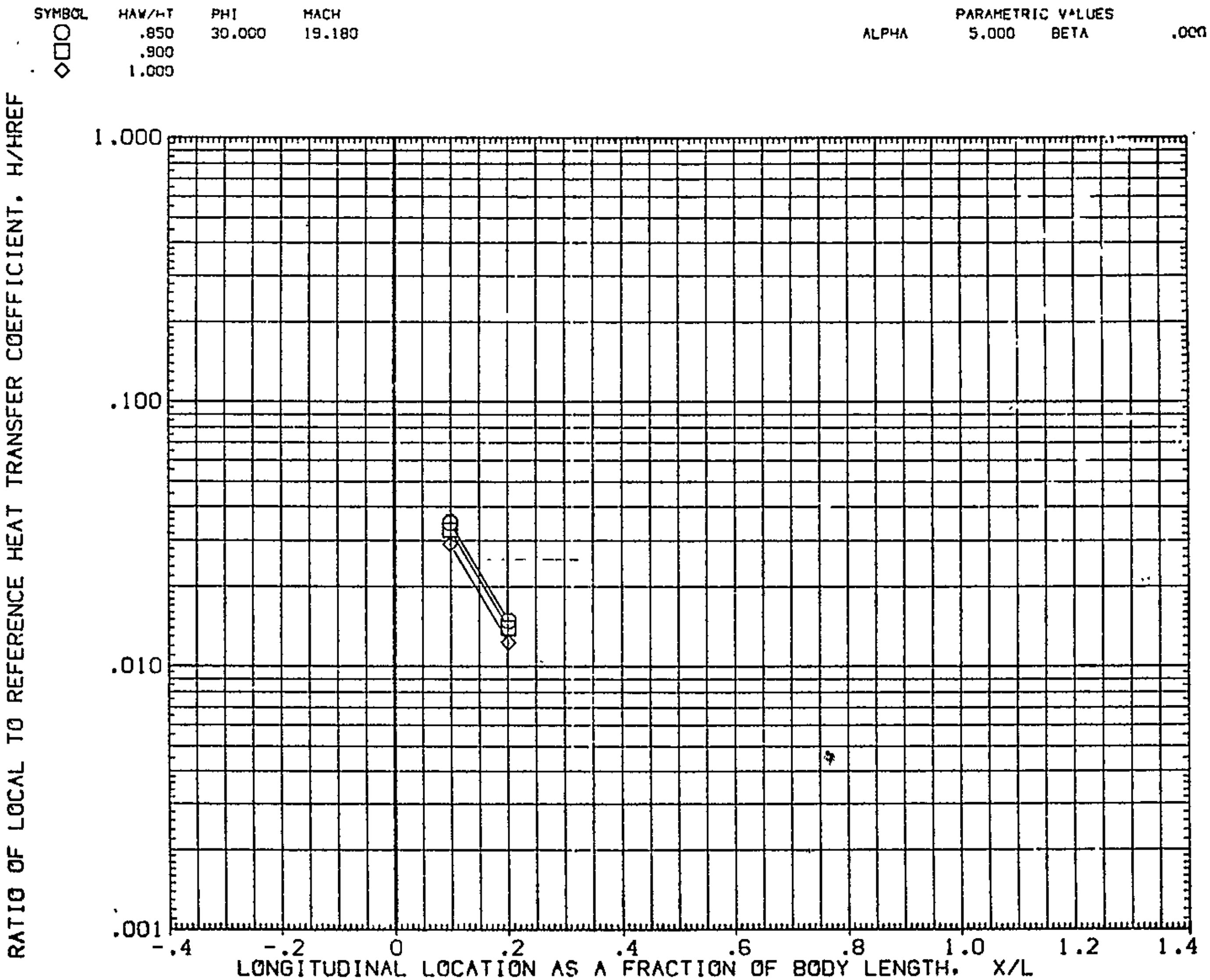

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

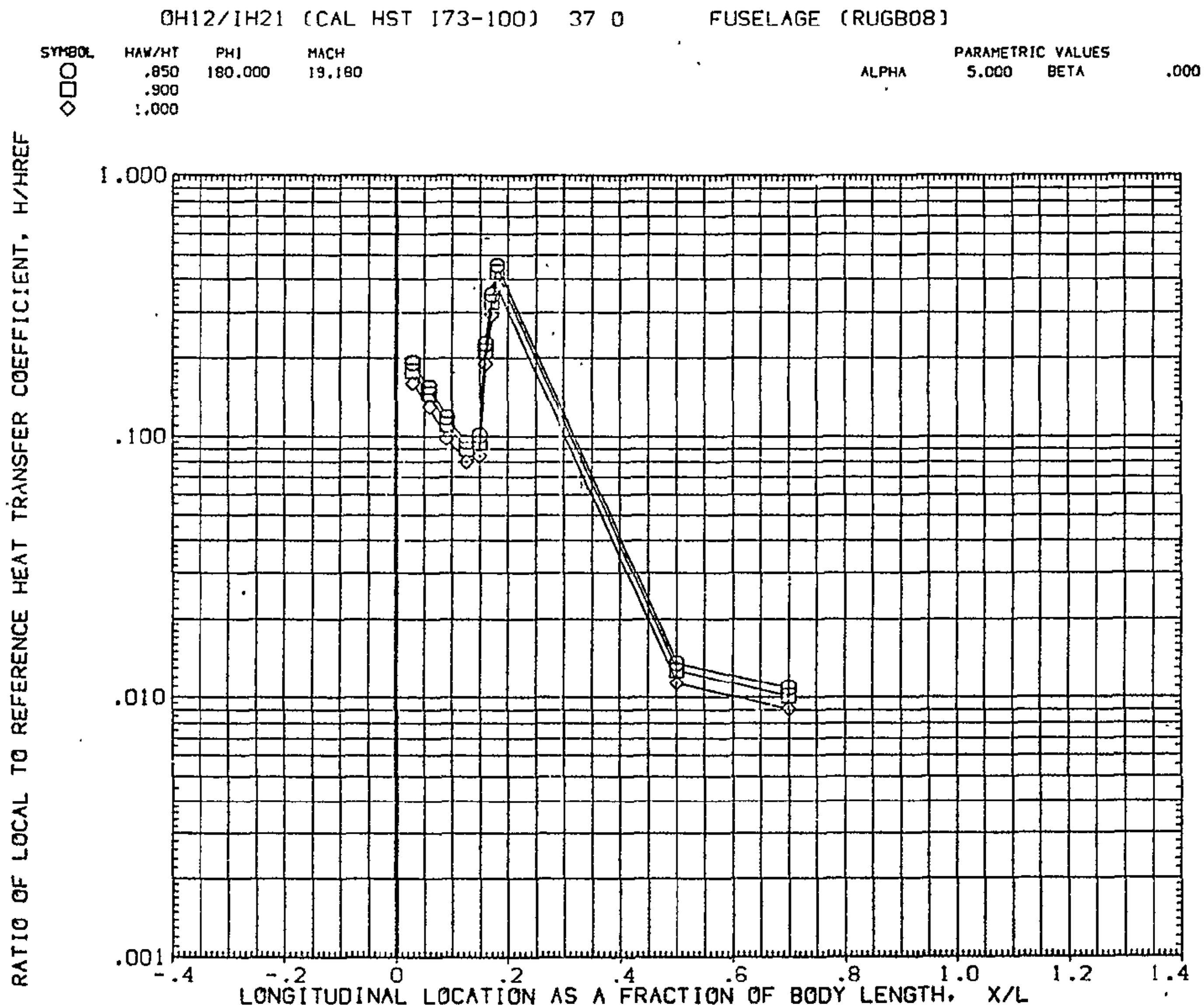

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

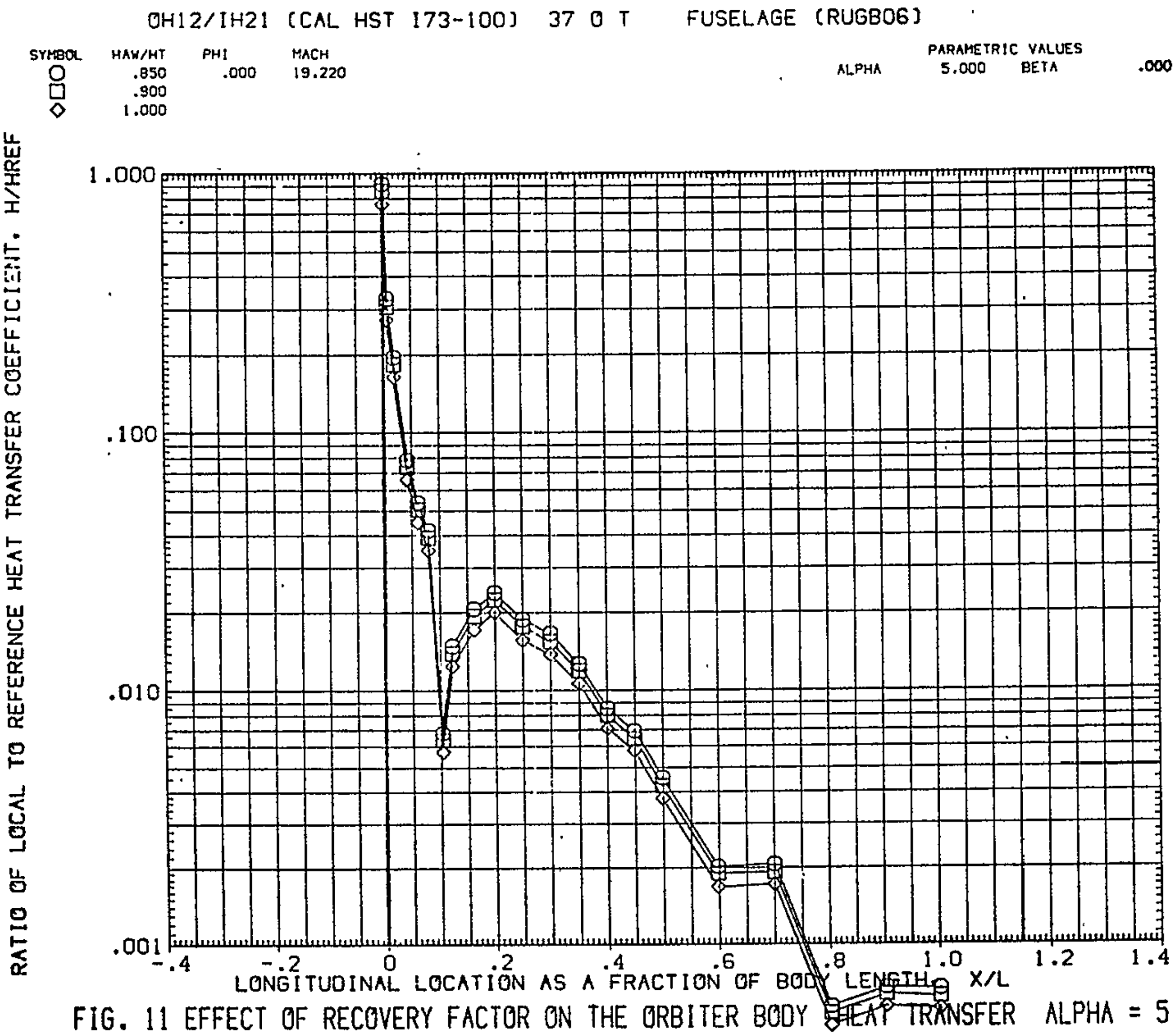

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

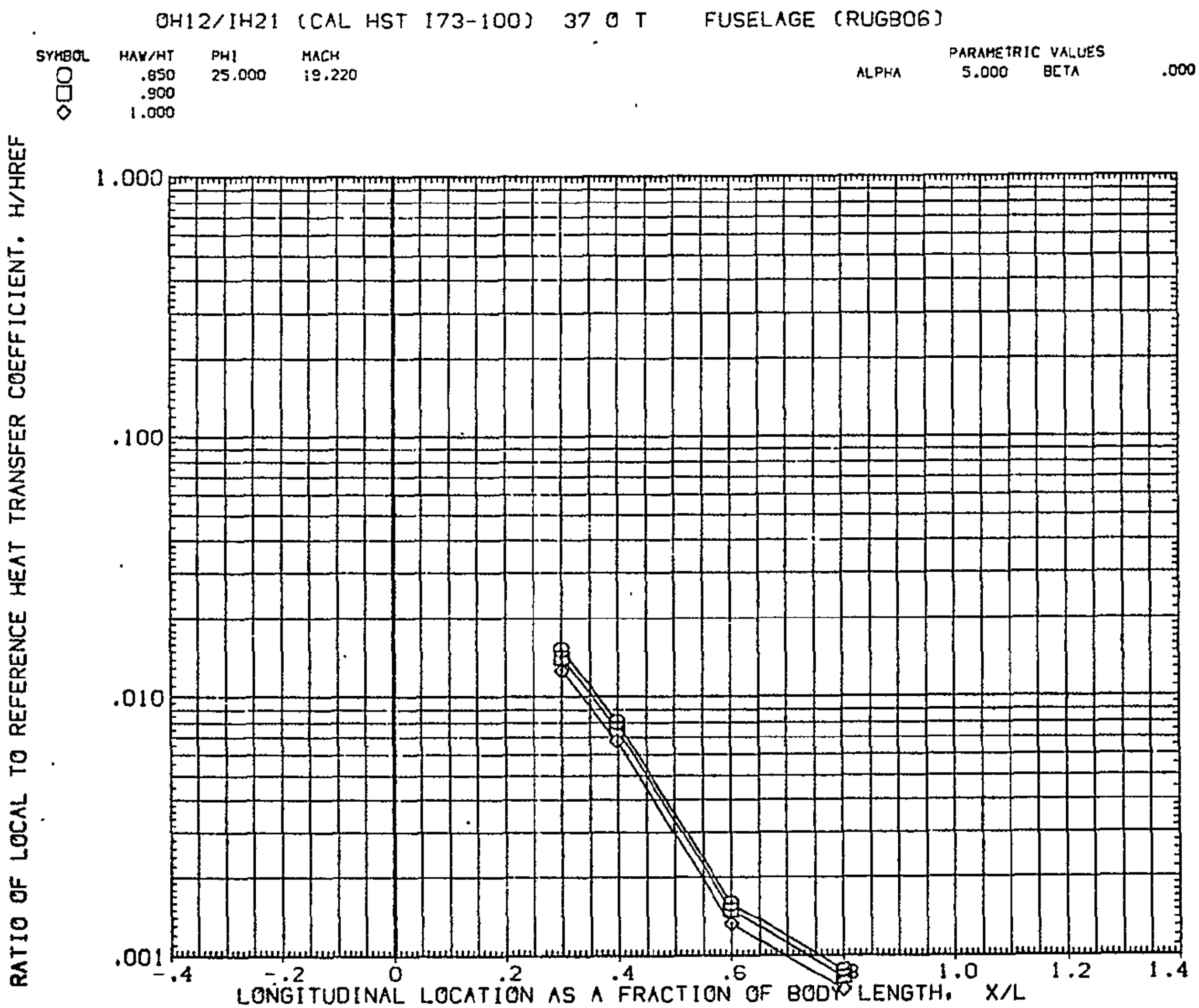

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

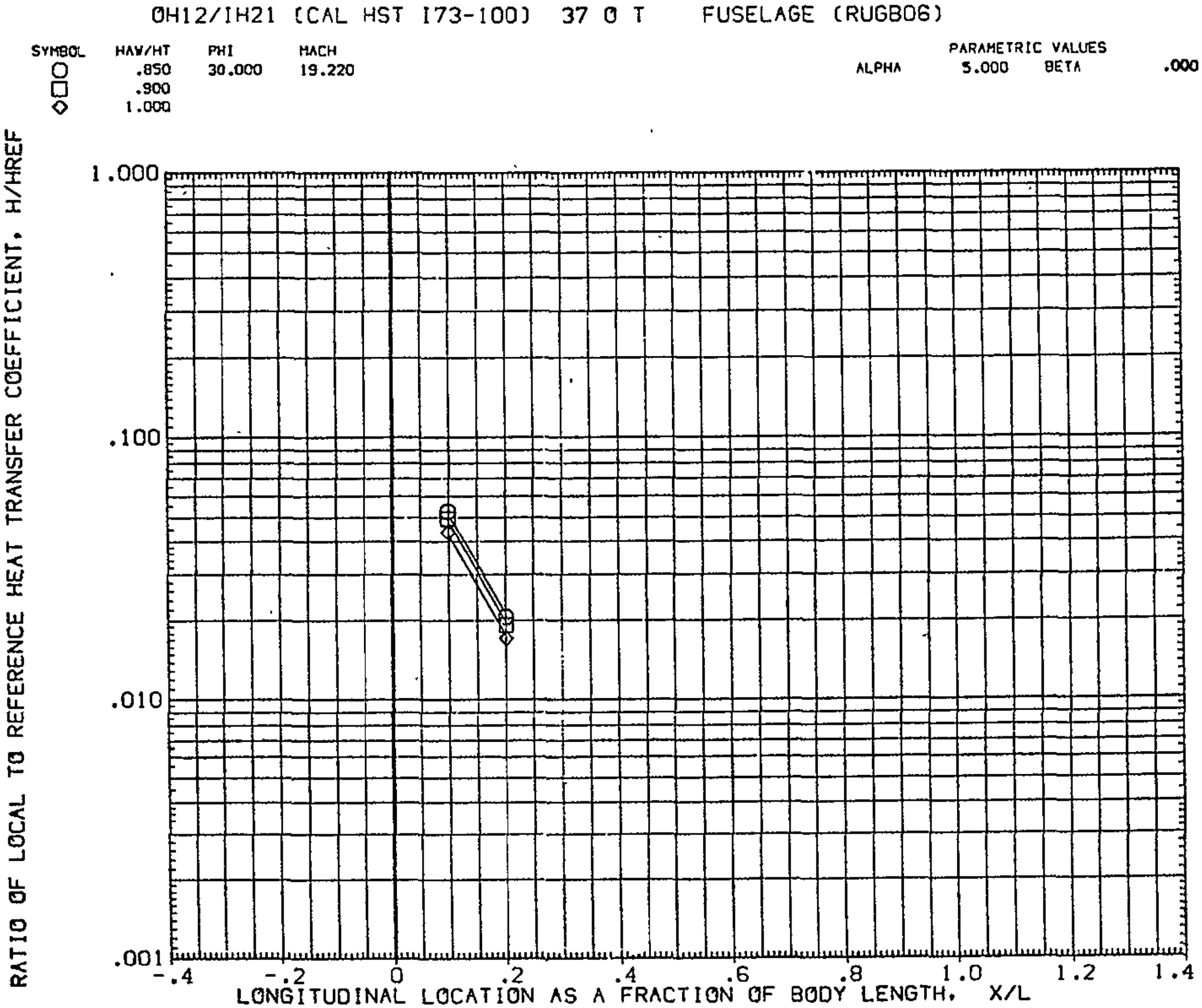

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST 173-100) 37 0 T FUSELAGE (RUGB06)

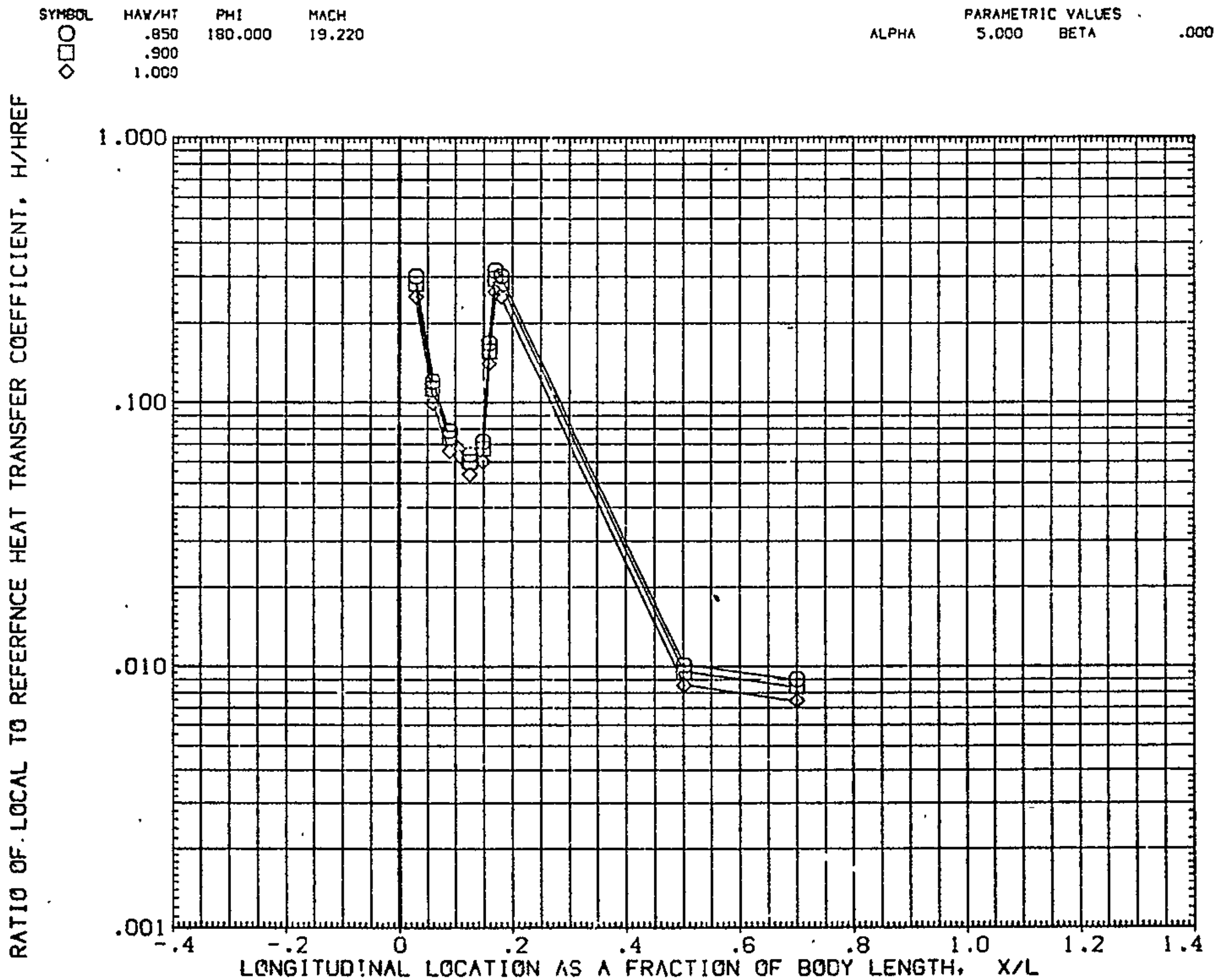

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

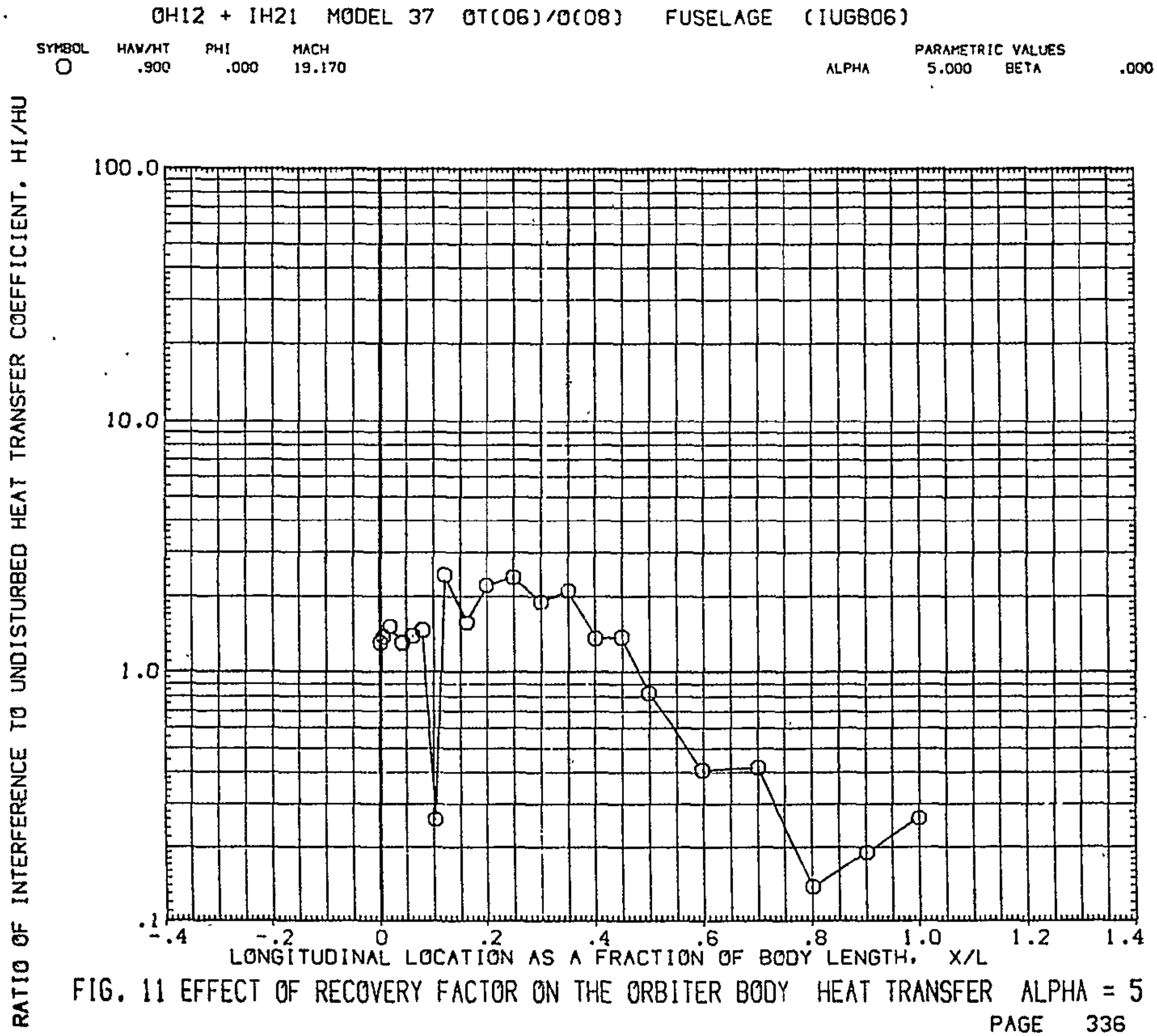

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) FUSELAGE (IUGB06)

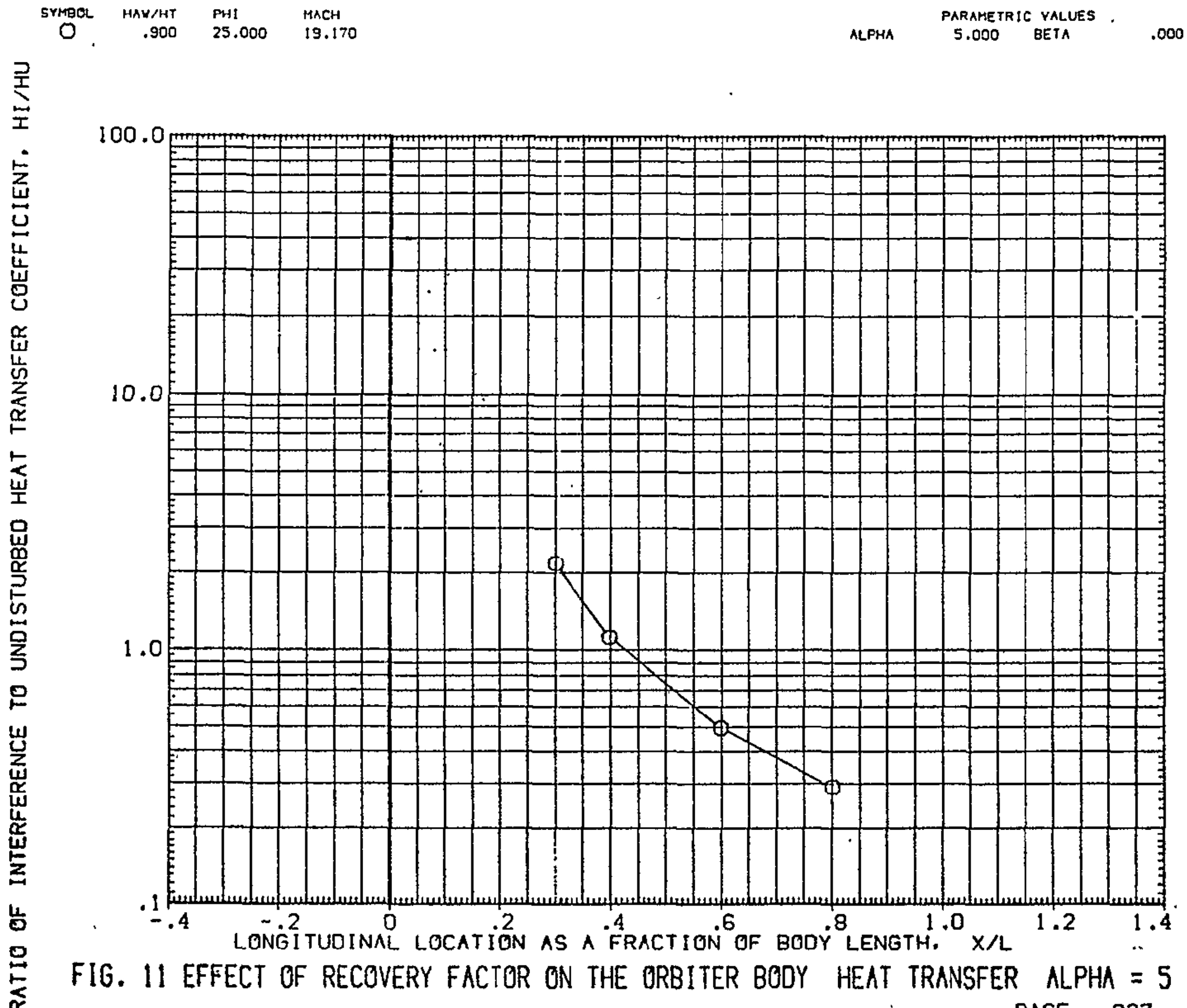

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) FUSELAGE (IUGB06)

SYMBOL	HAW/HT	PHI	MACH
O	.900	30.000	19.170

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

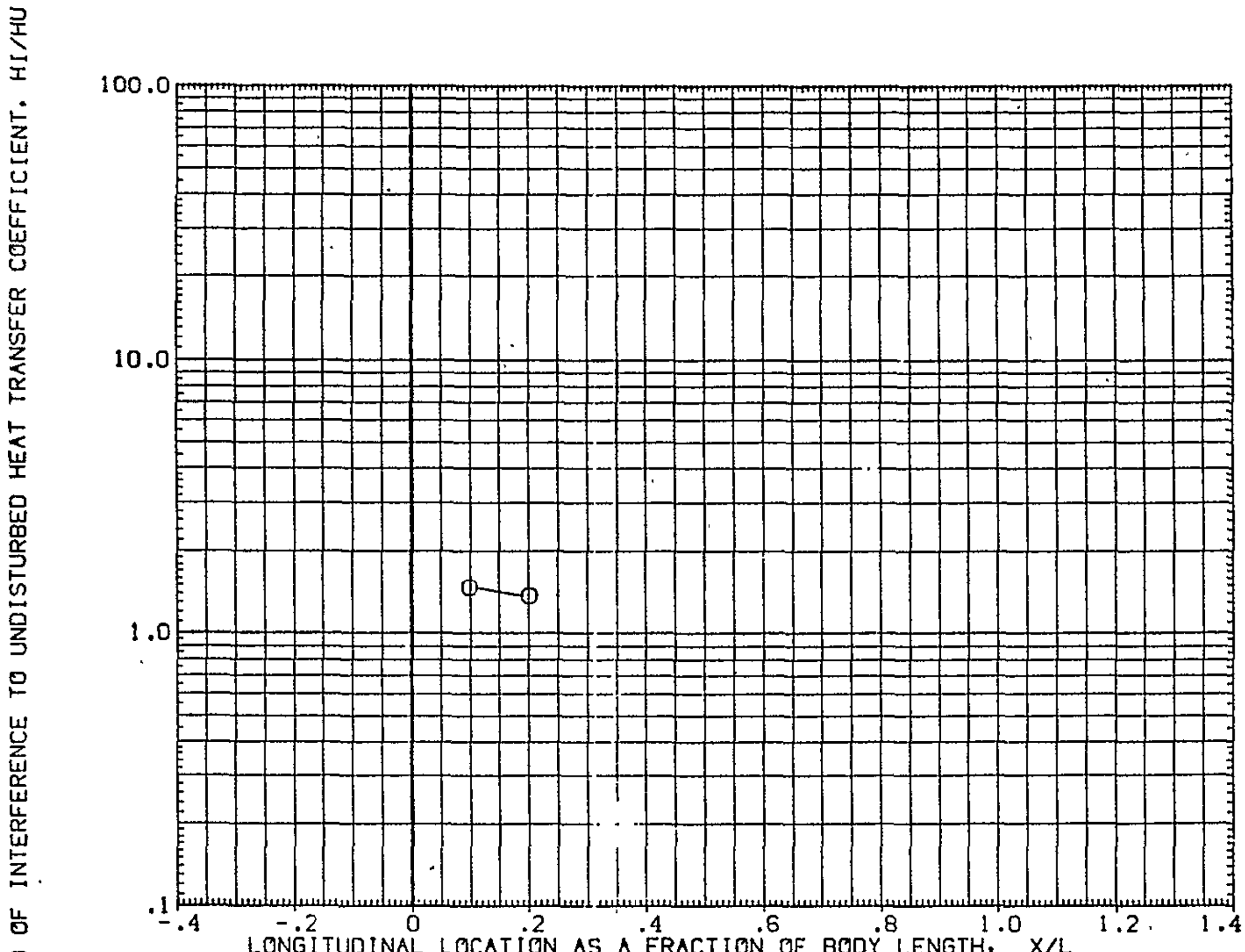

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

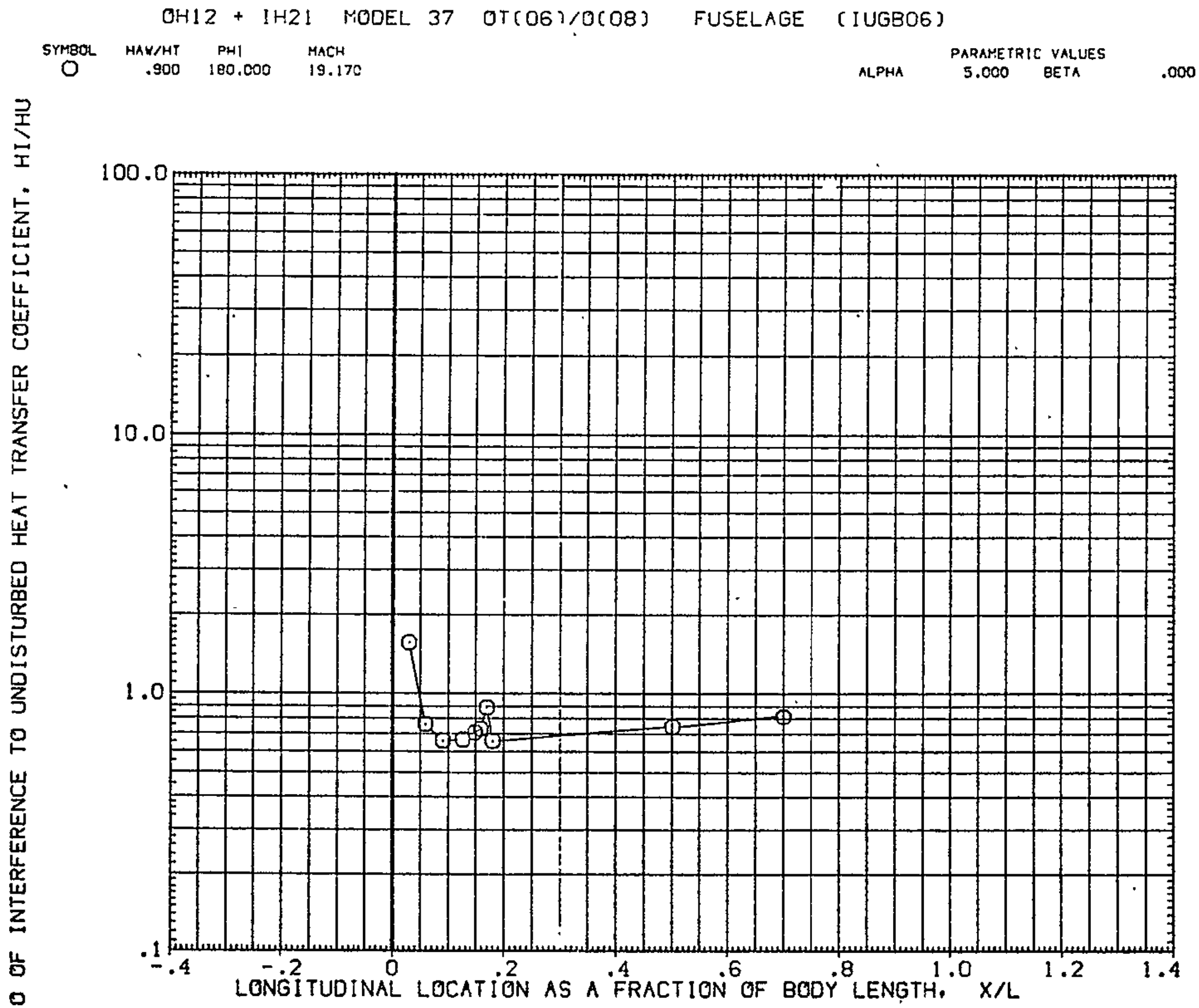

FIG. 11 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW08)

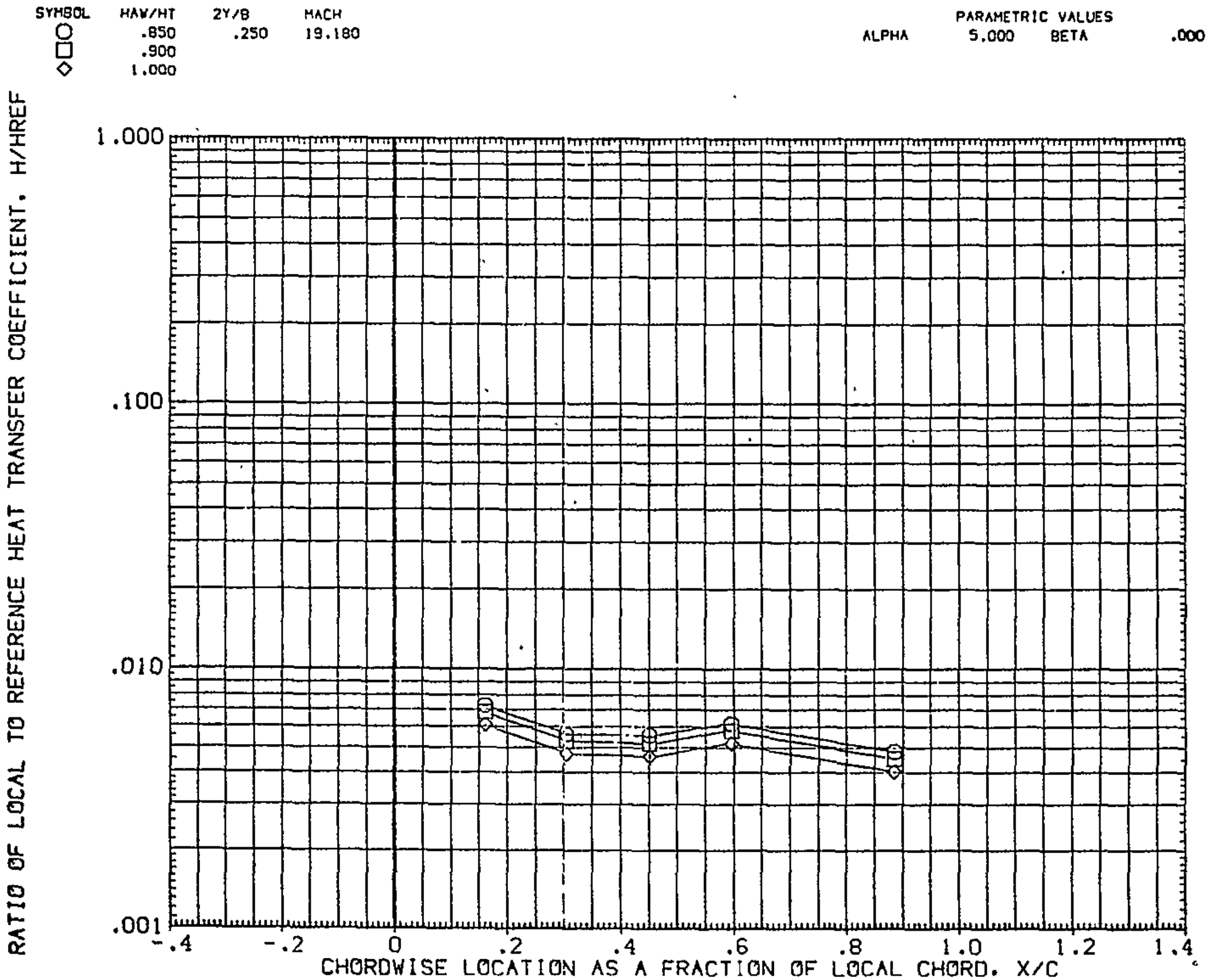

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

0H12/IH21 (CAL HST I73-100) 37 0 WING L.S.(RUGW08)

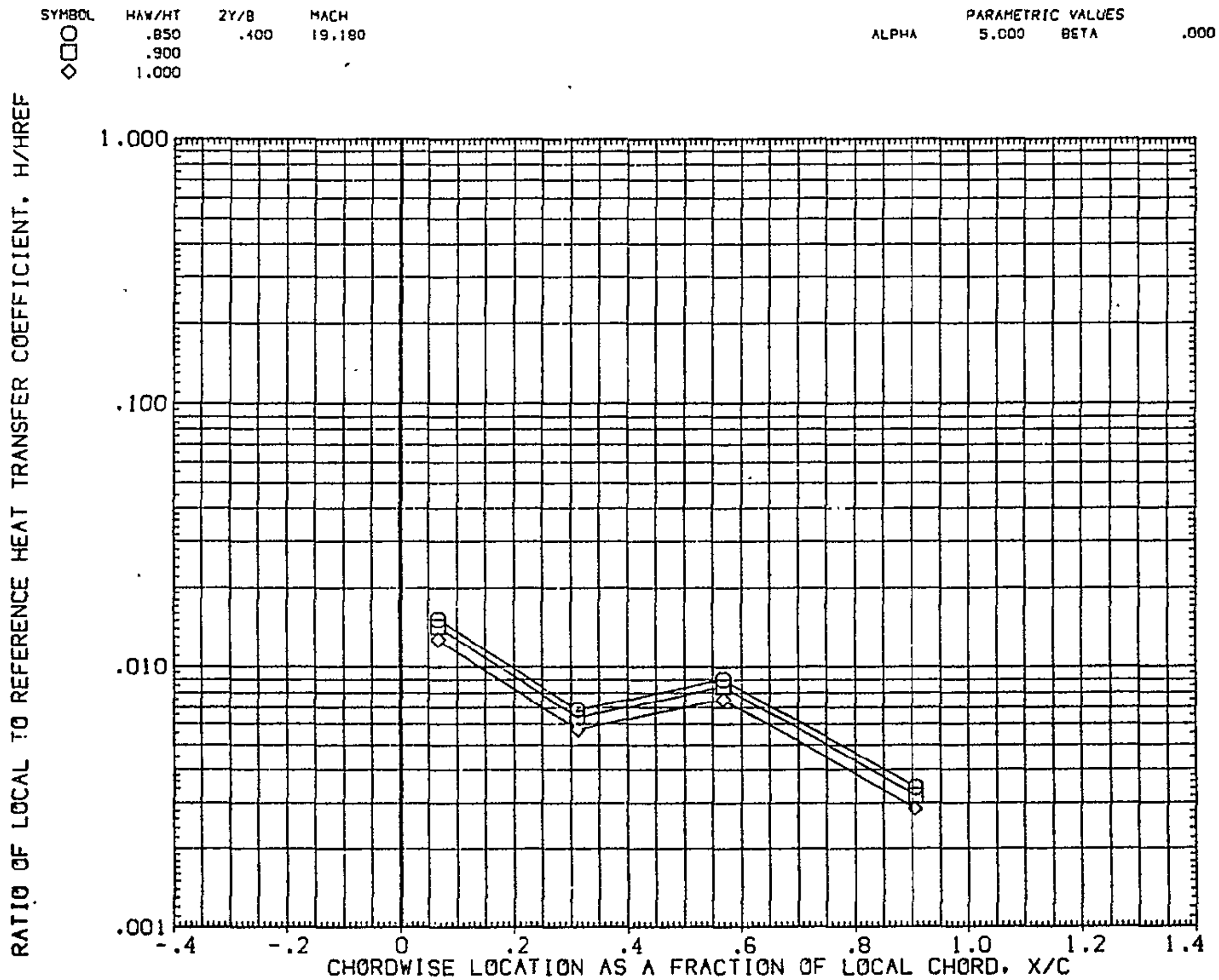

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

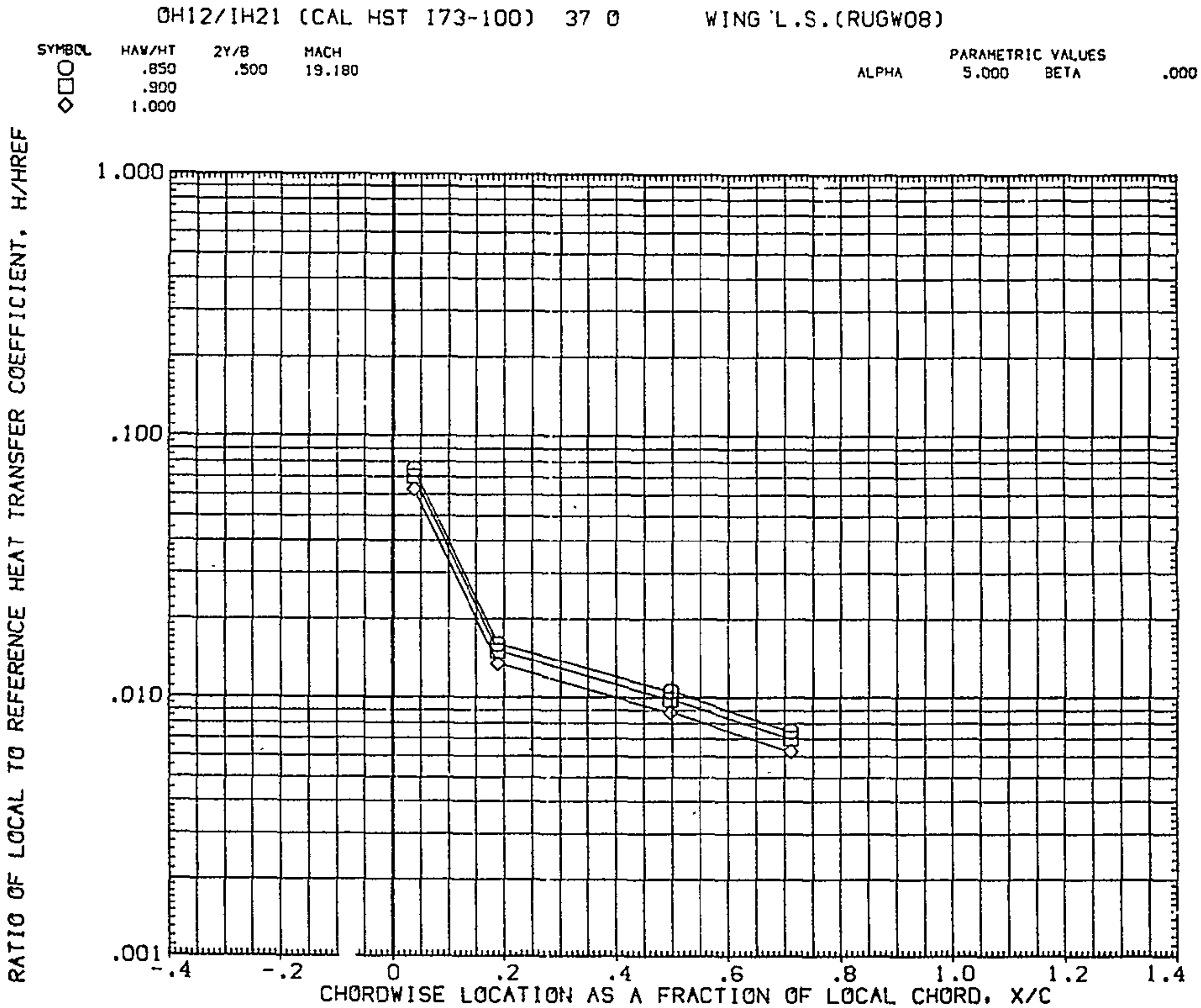

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

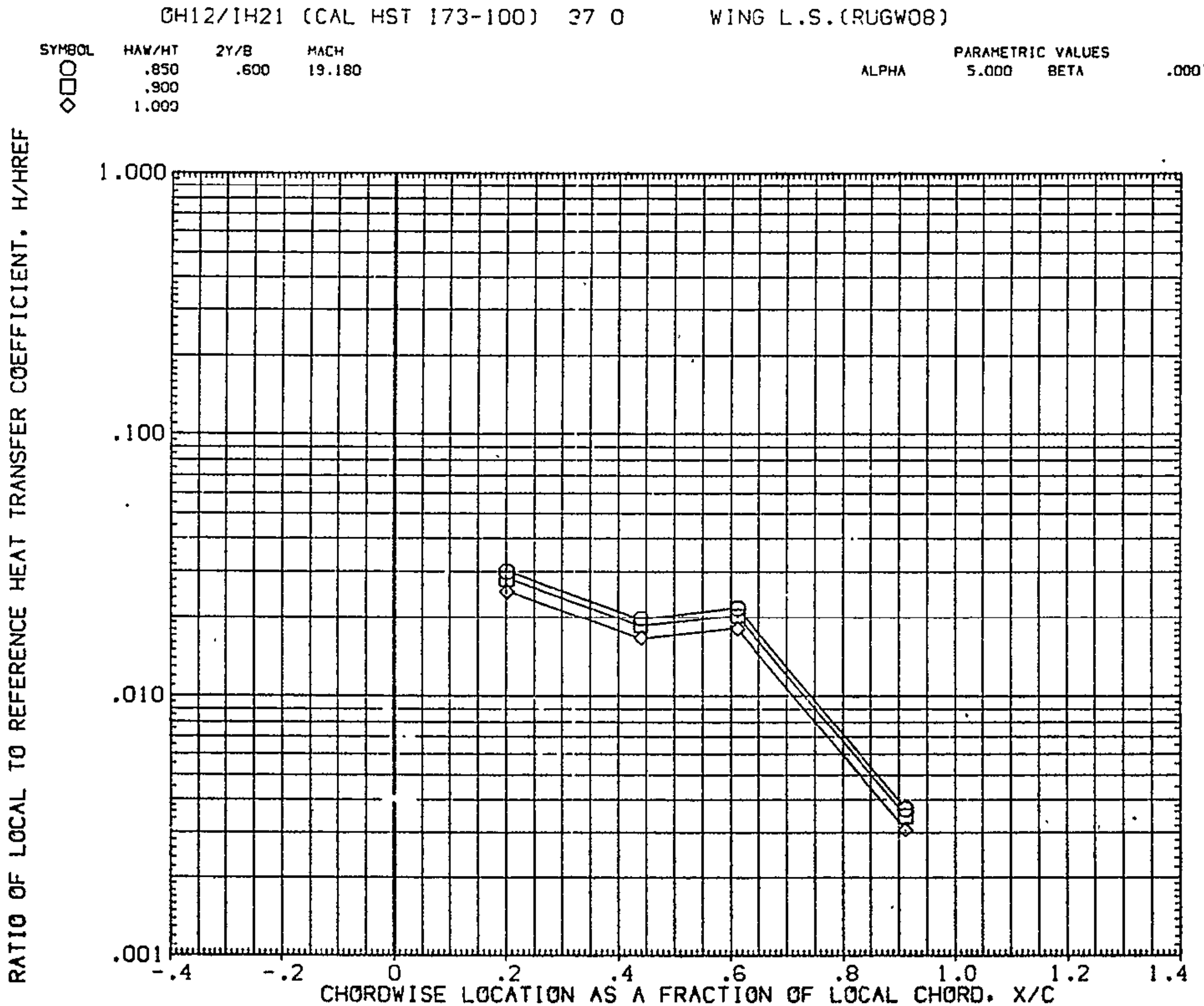

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

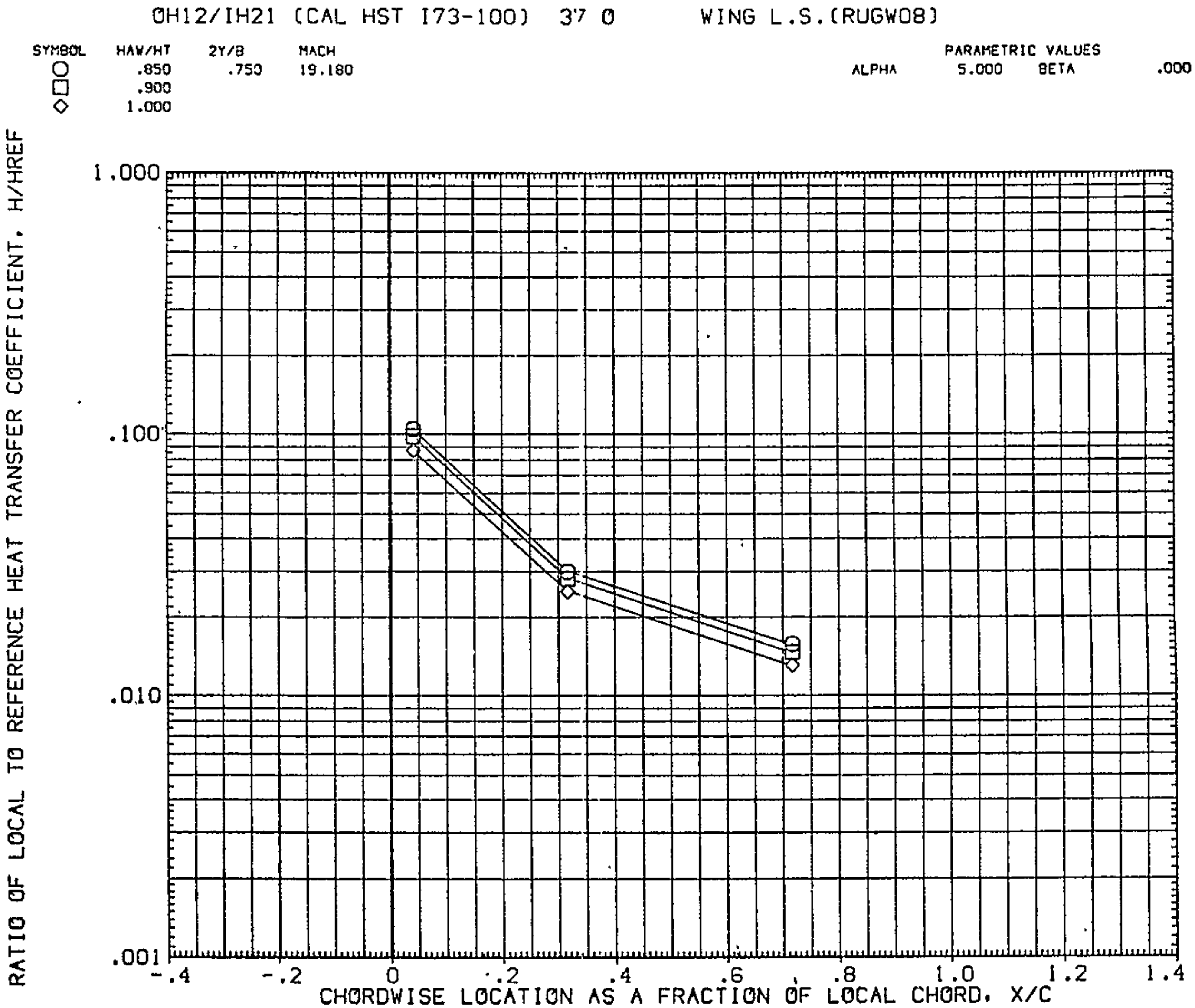

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

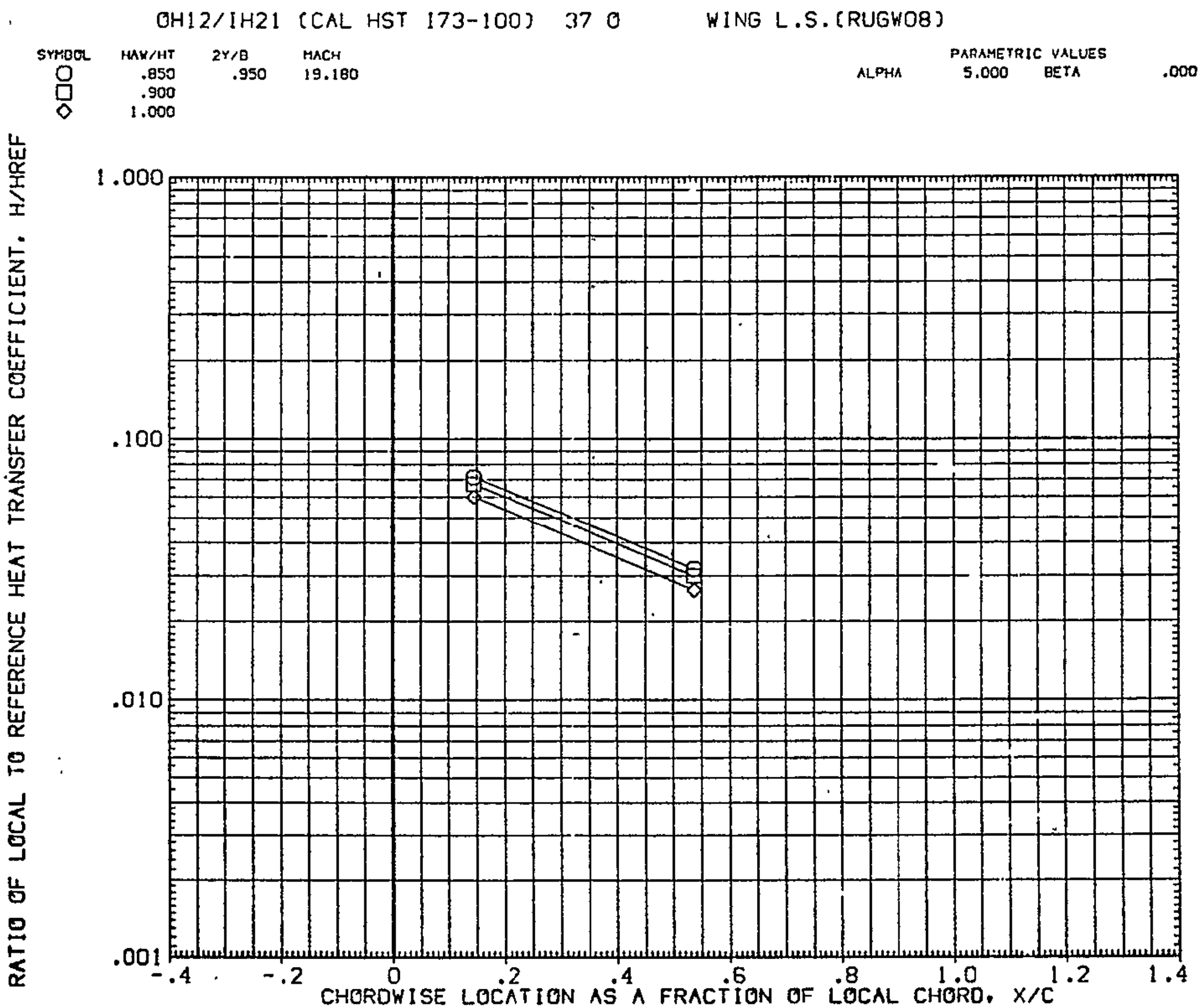

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW06)

SYMBOL	HAW/HT	2Y/B	MACH
○	.850	.250	19.220
□	.900		
◇	1.000		

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

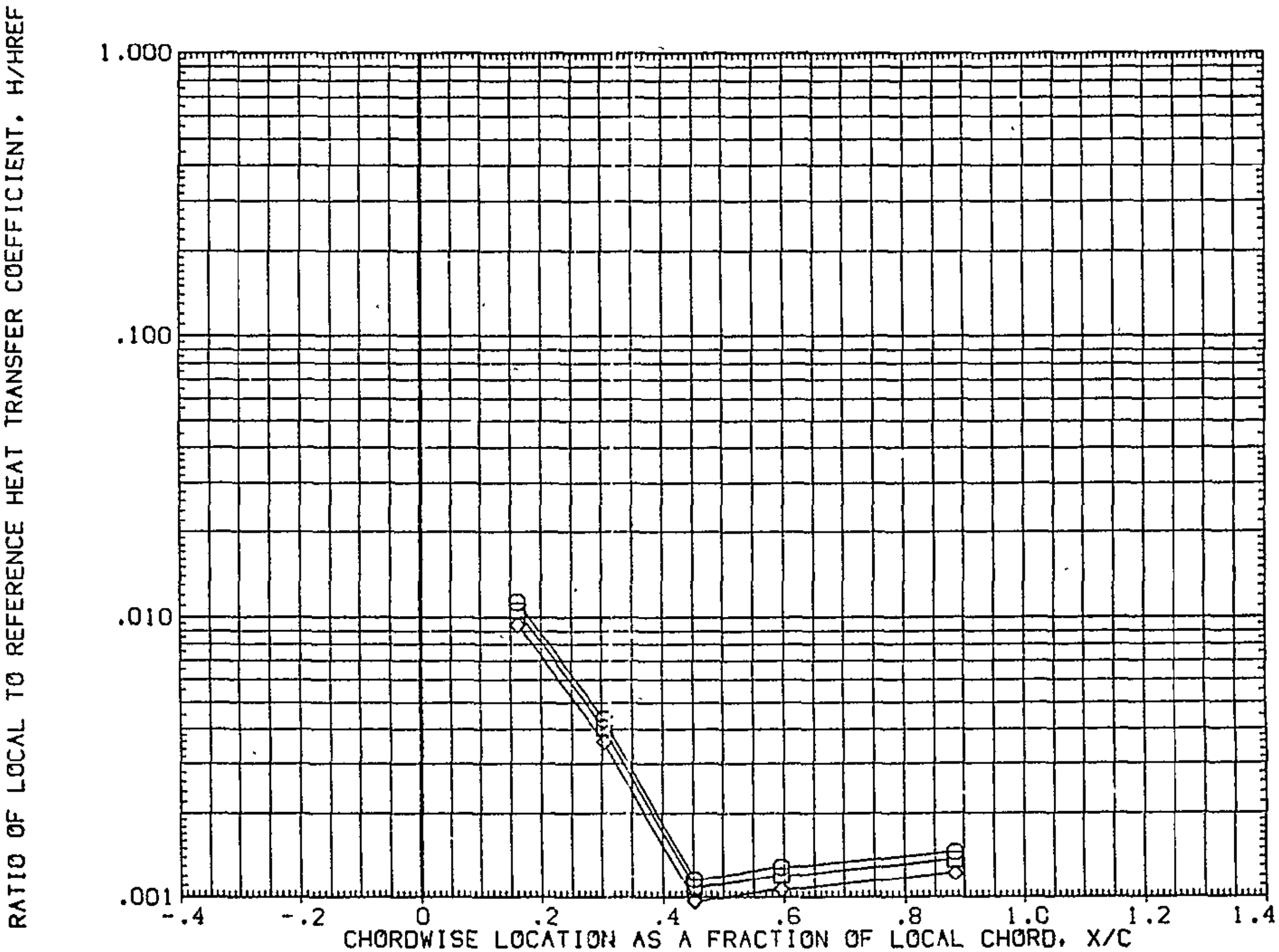

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

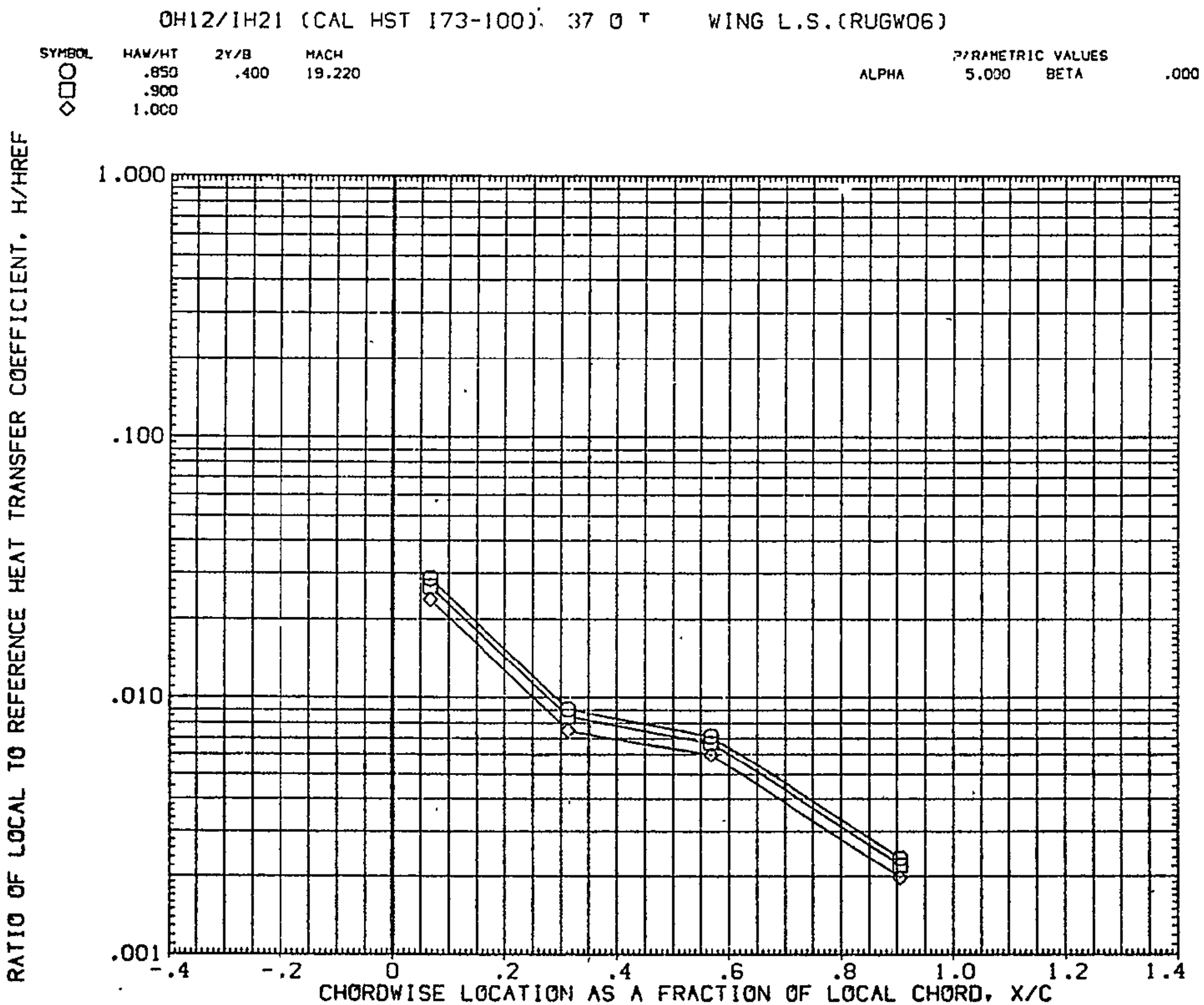

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST 173-100) 37 0 T WING L.S.(RUGW06)

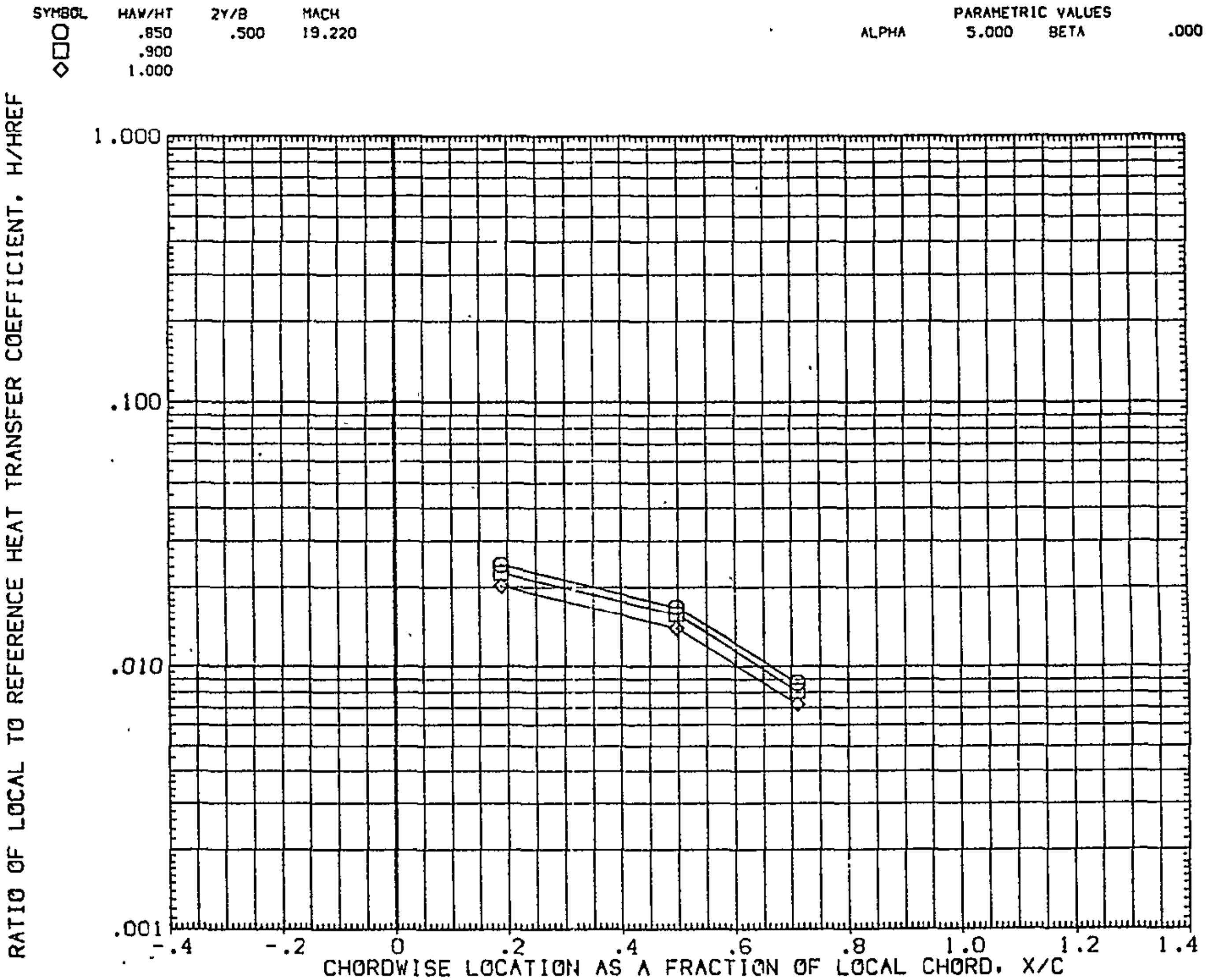

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW06)

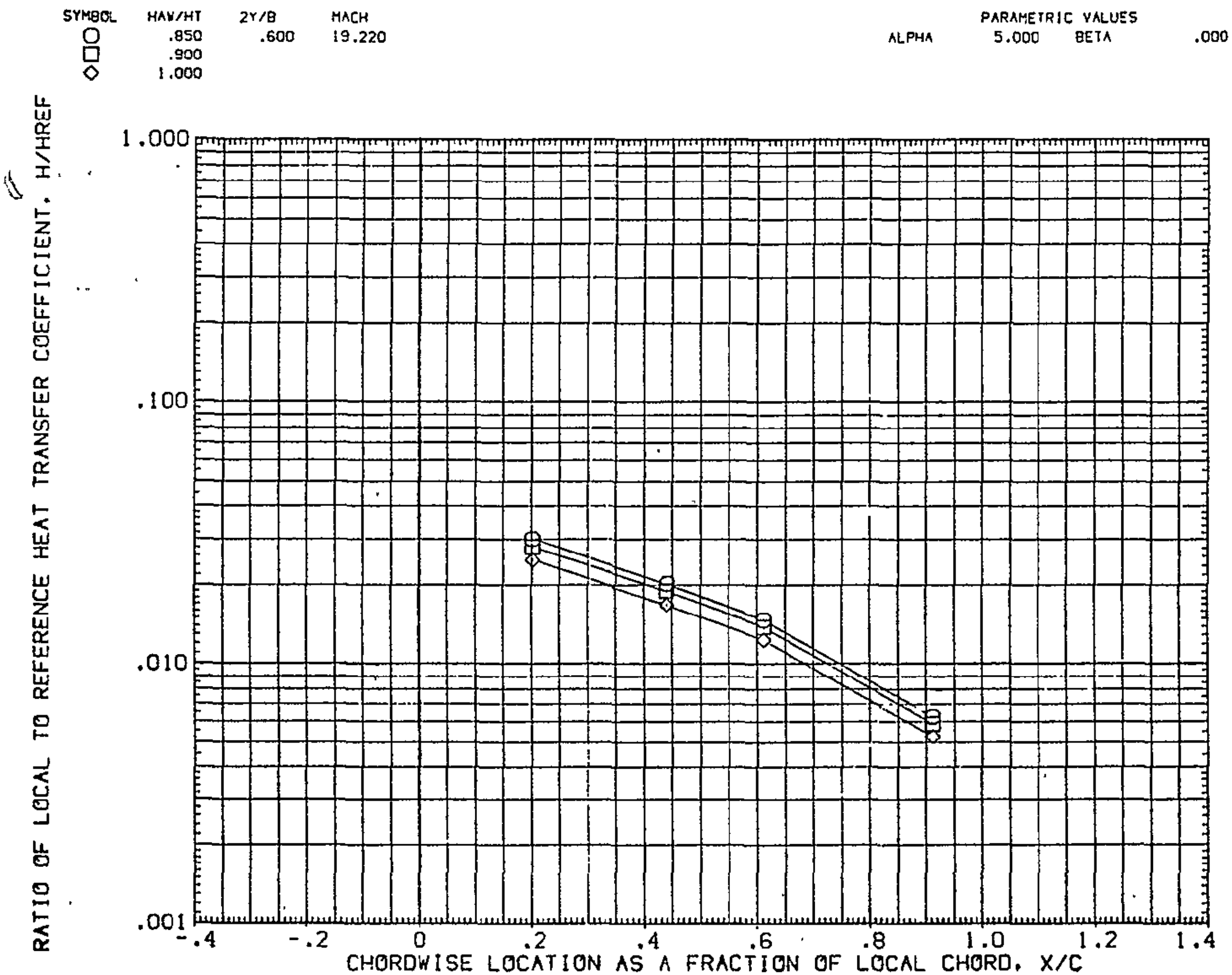

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

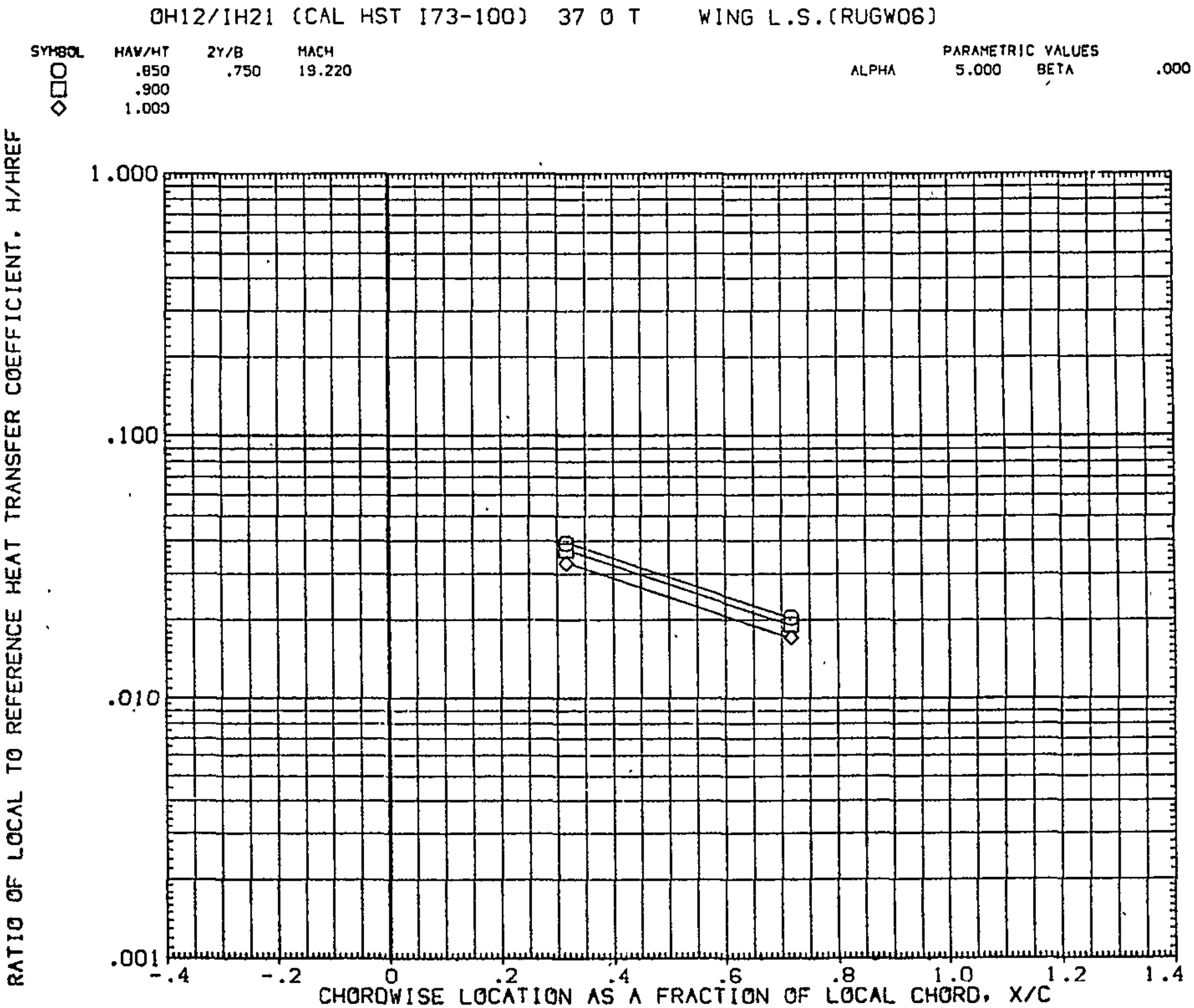

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW06)

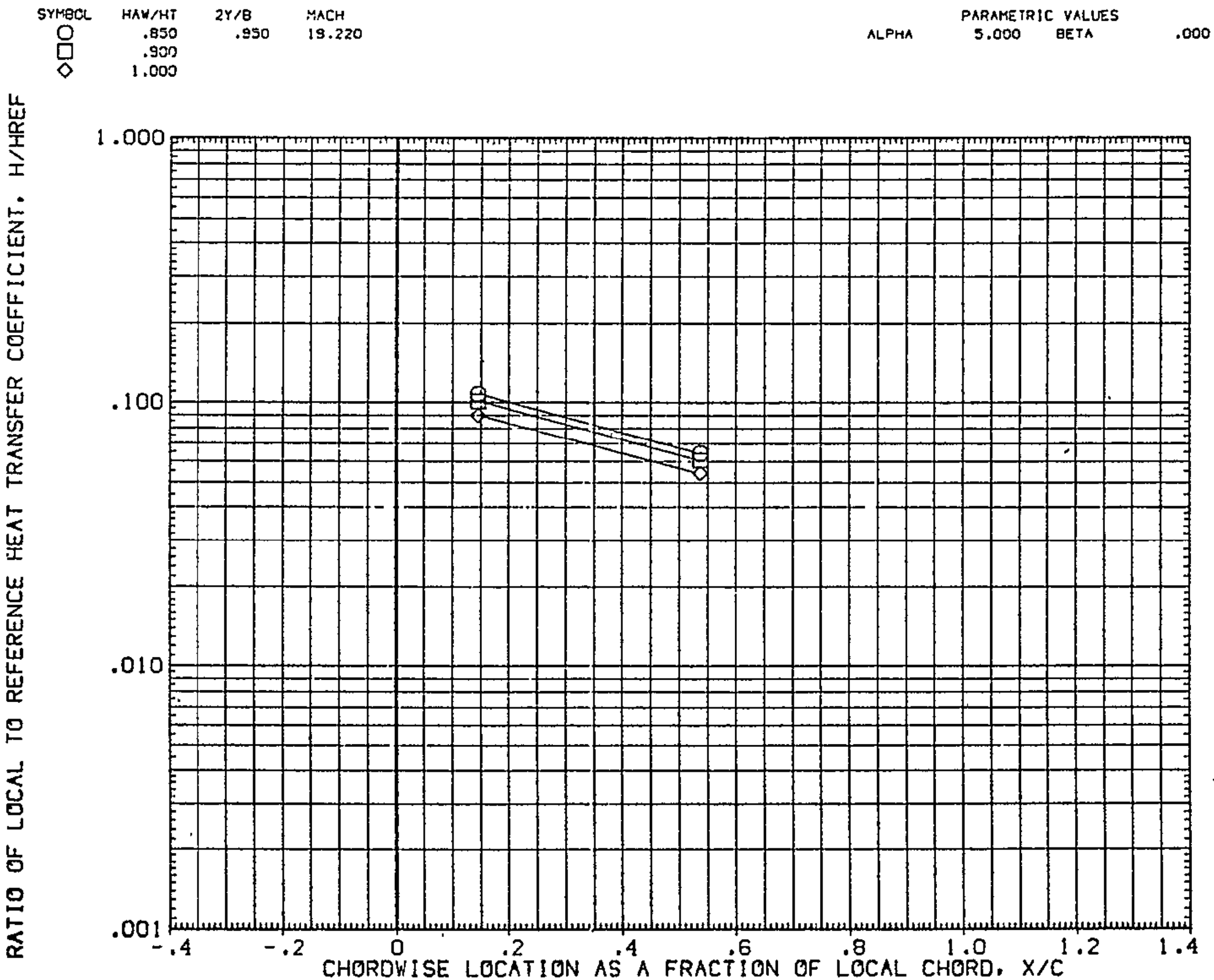

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.250	19.170

PARAMETRIC VALUES

ALPHA 5.000 BETA .000

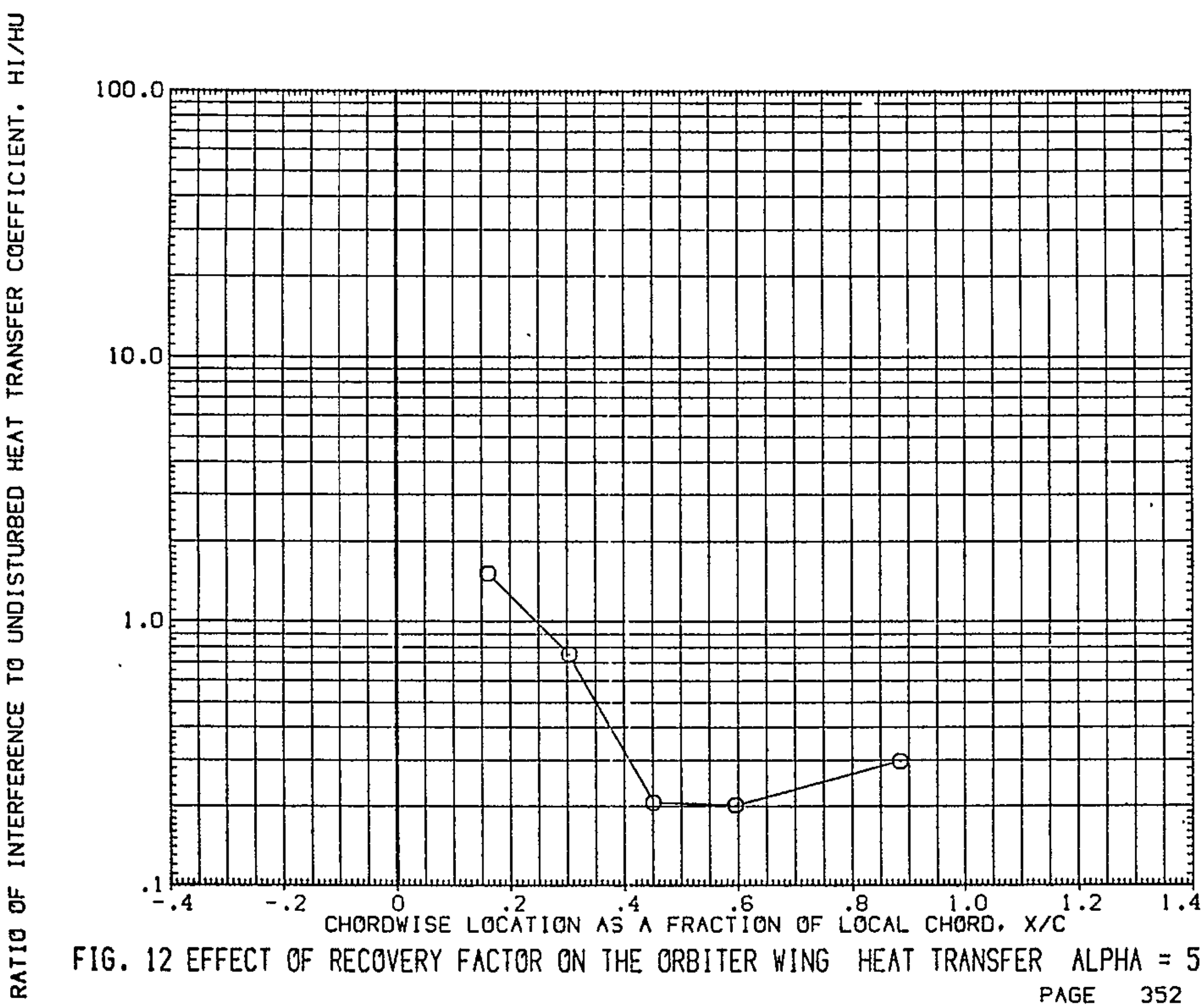

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

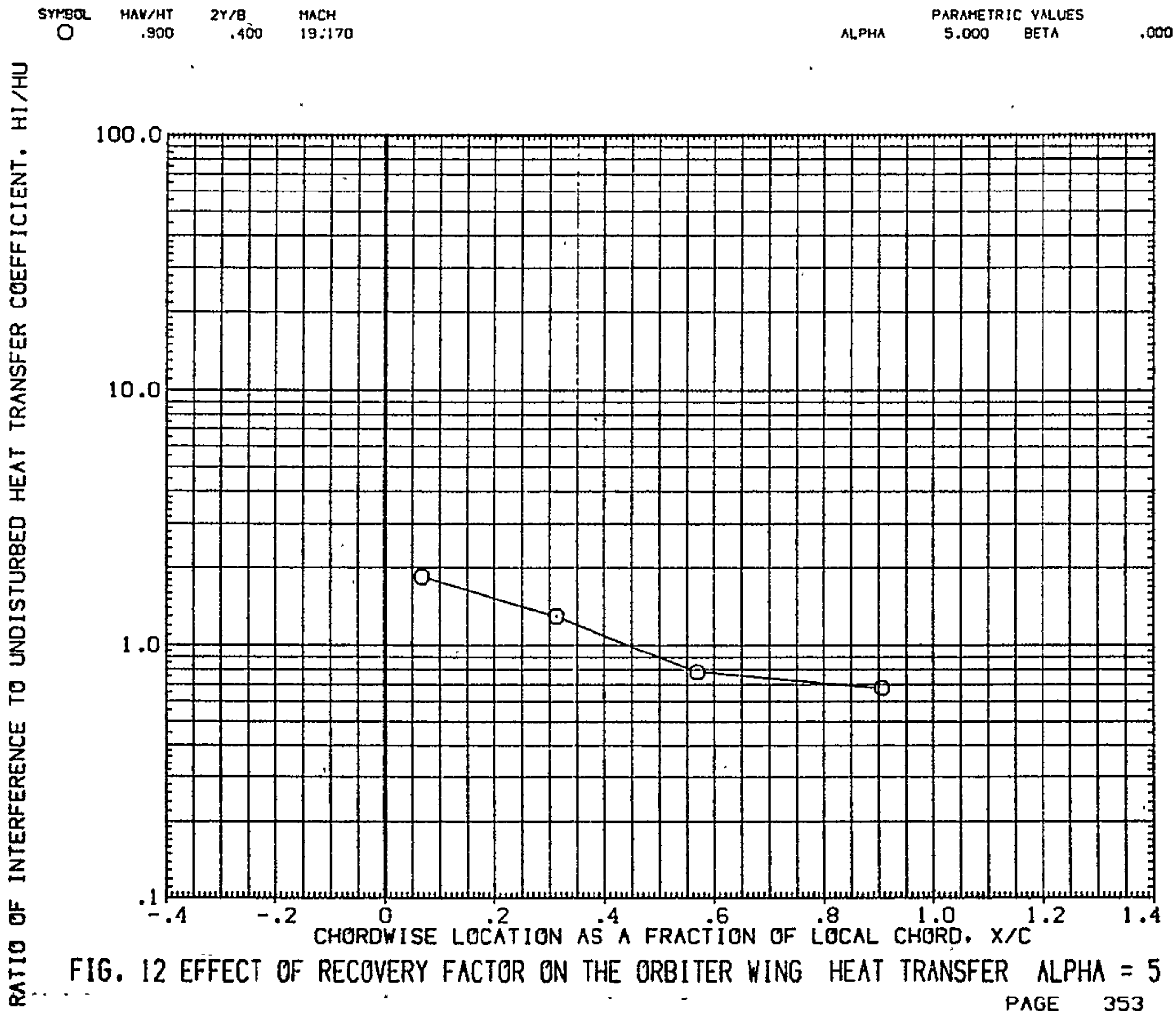

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

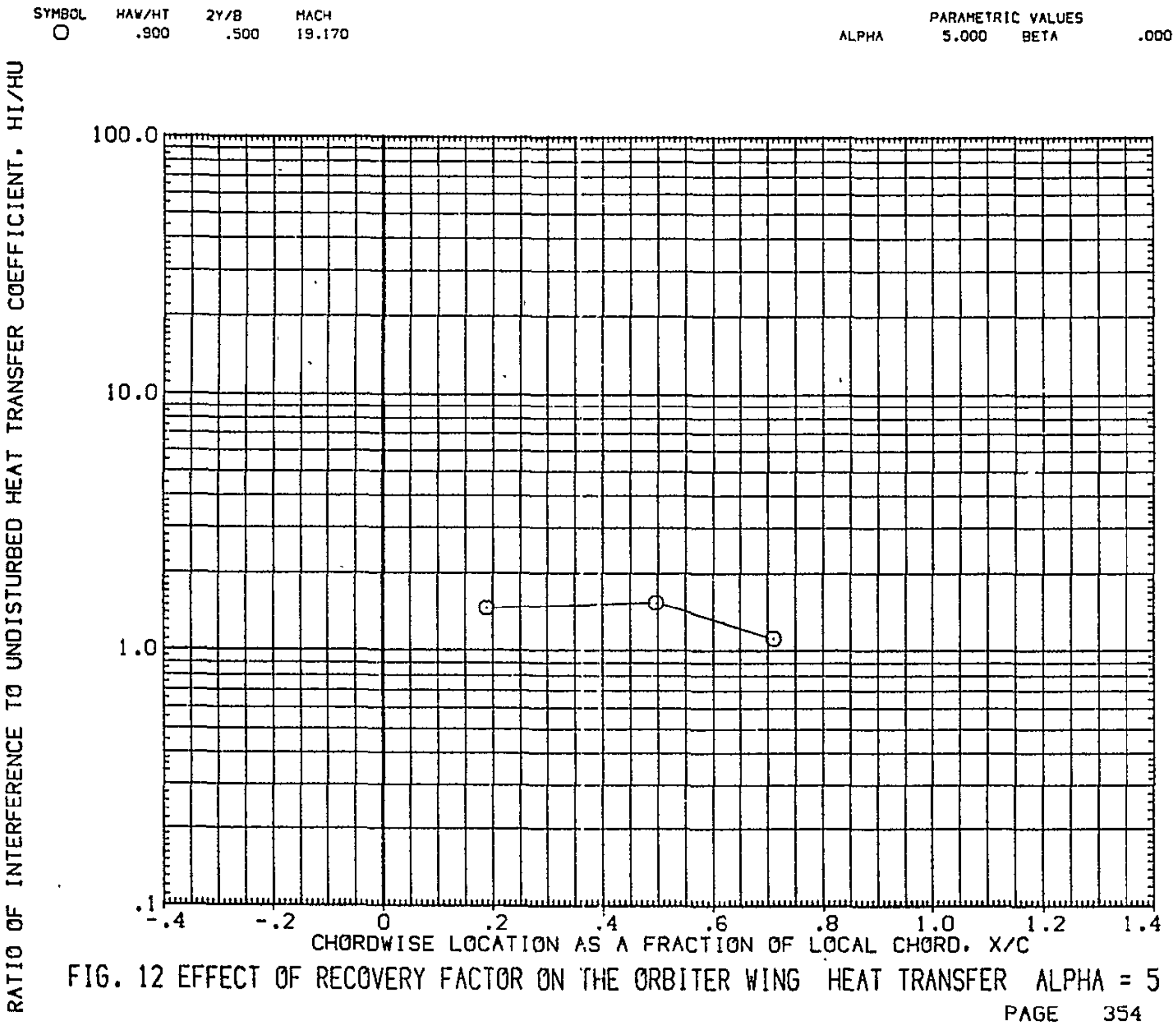

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

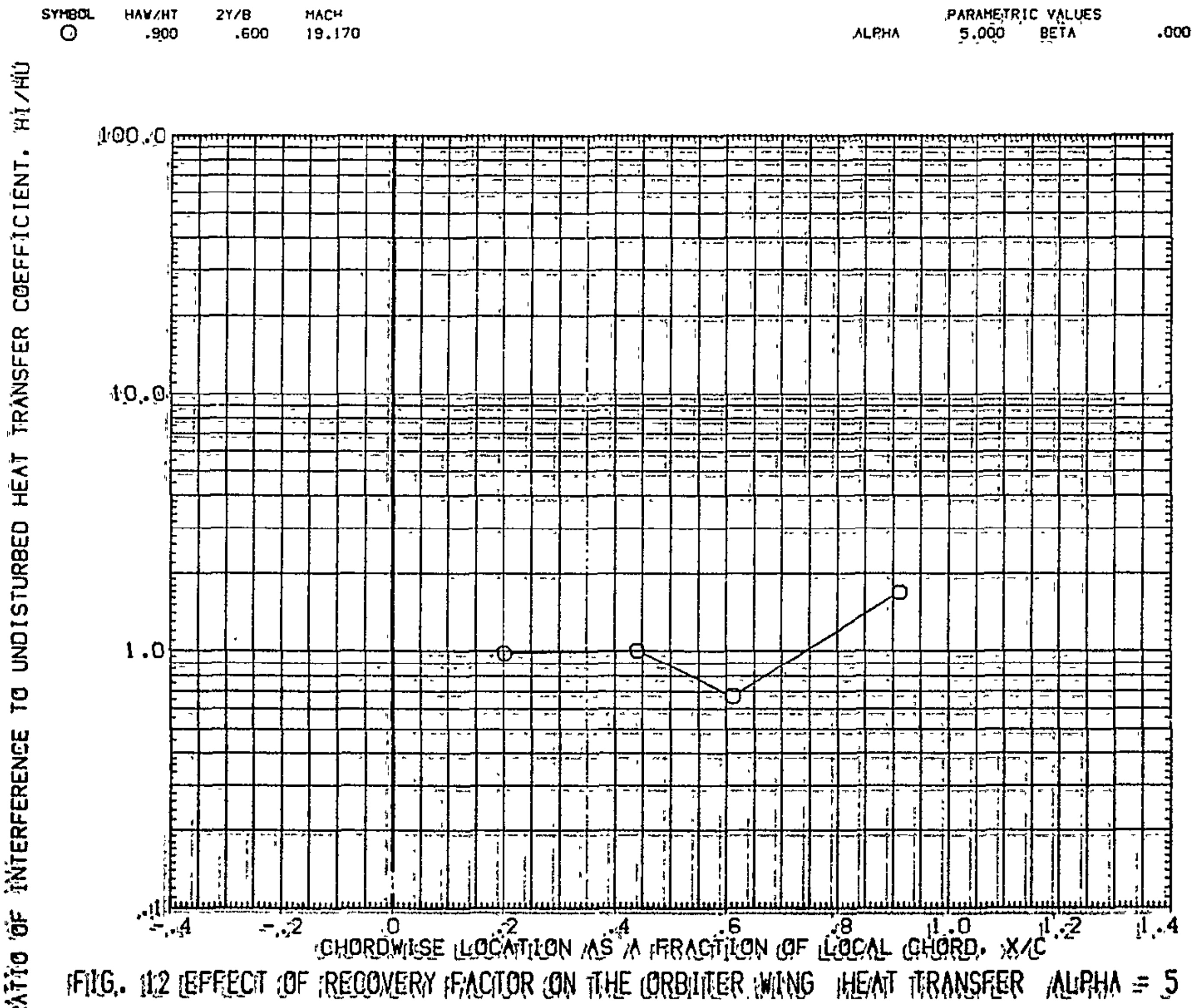

FIG. 112 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

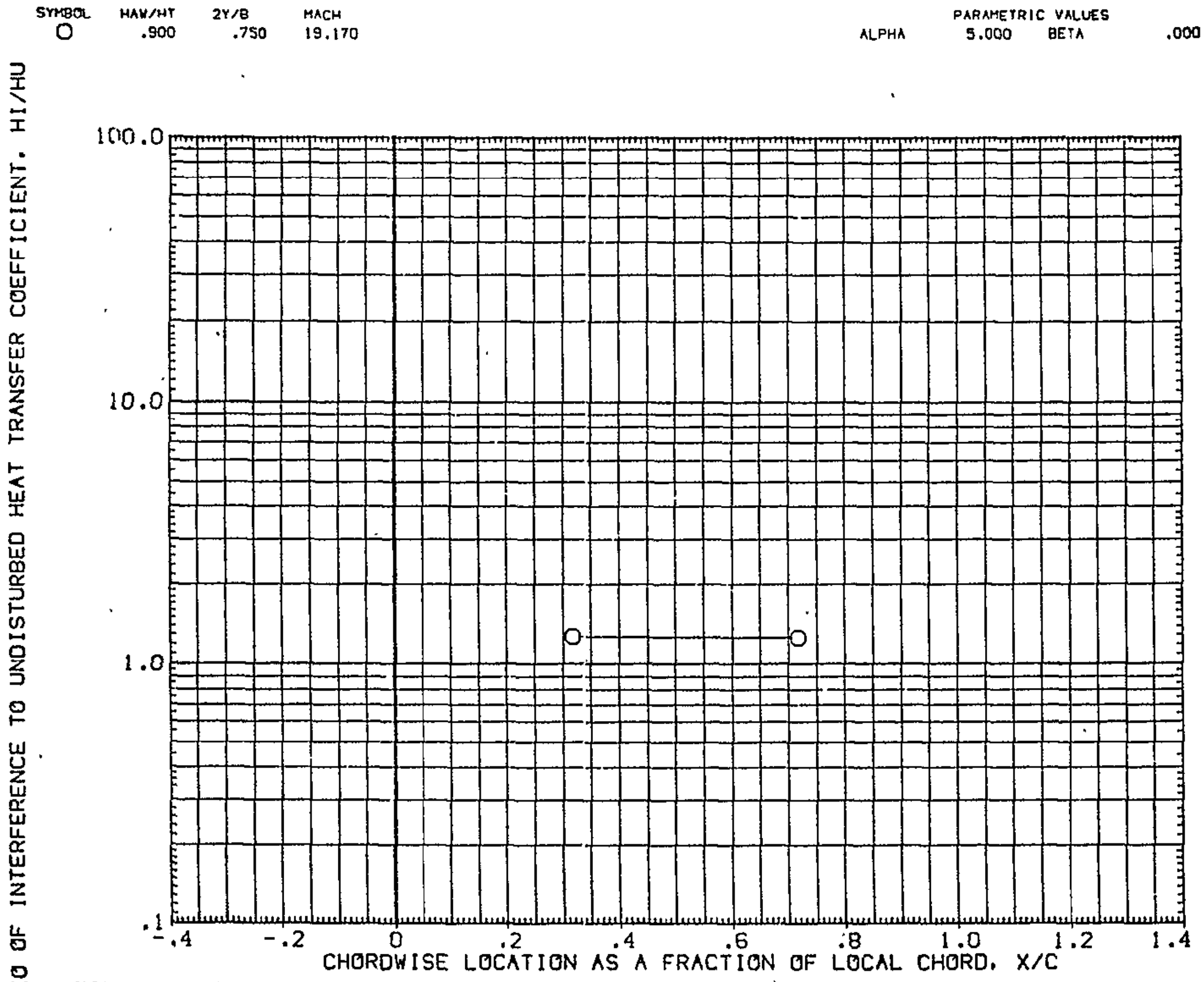

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) WING L.S. (IUGW06)

SYMBOL	HAW/HT	2Y/B	MACH
O	.900	.950	19.170

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

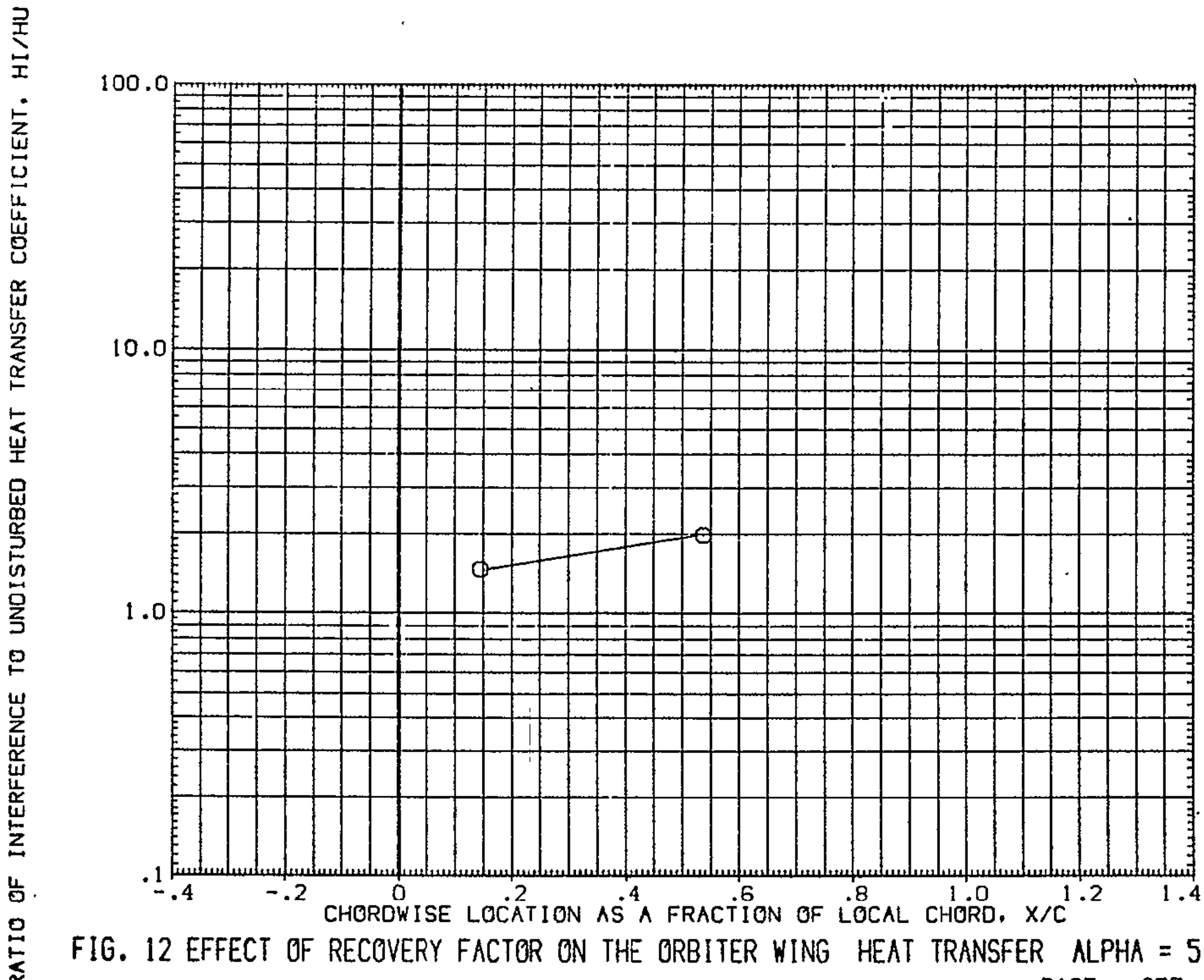

FIG. 12 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 5

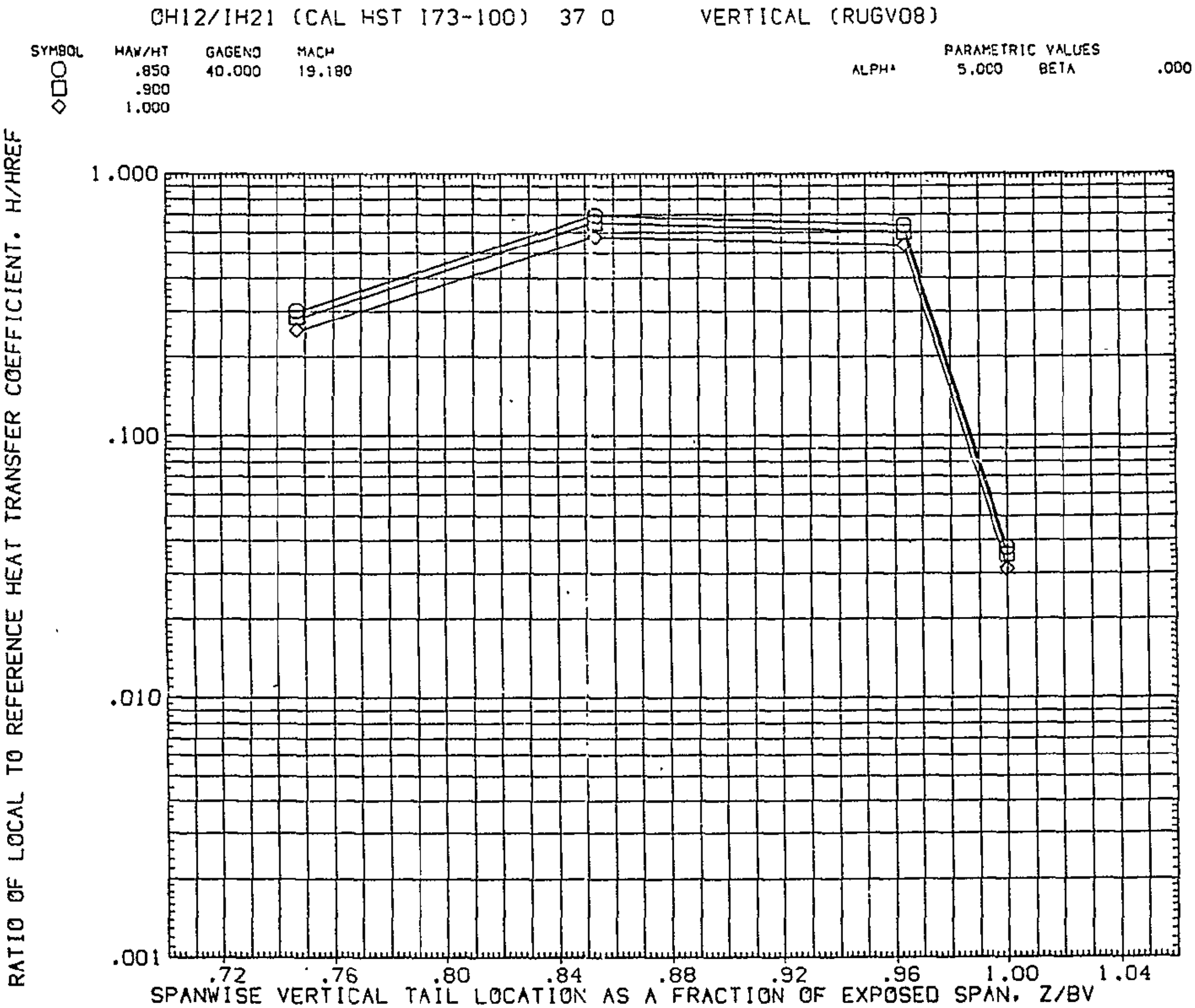

FIG. 13 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 5

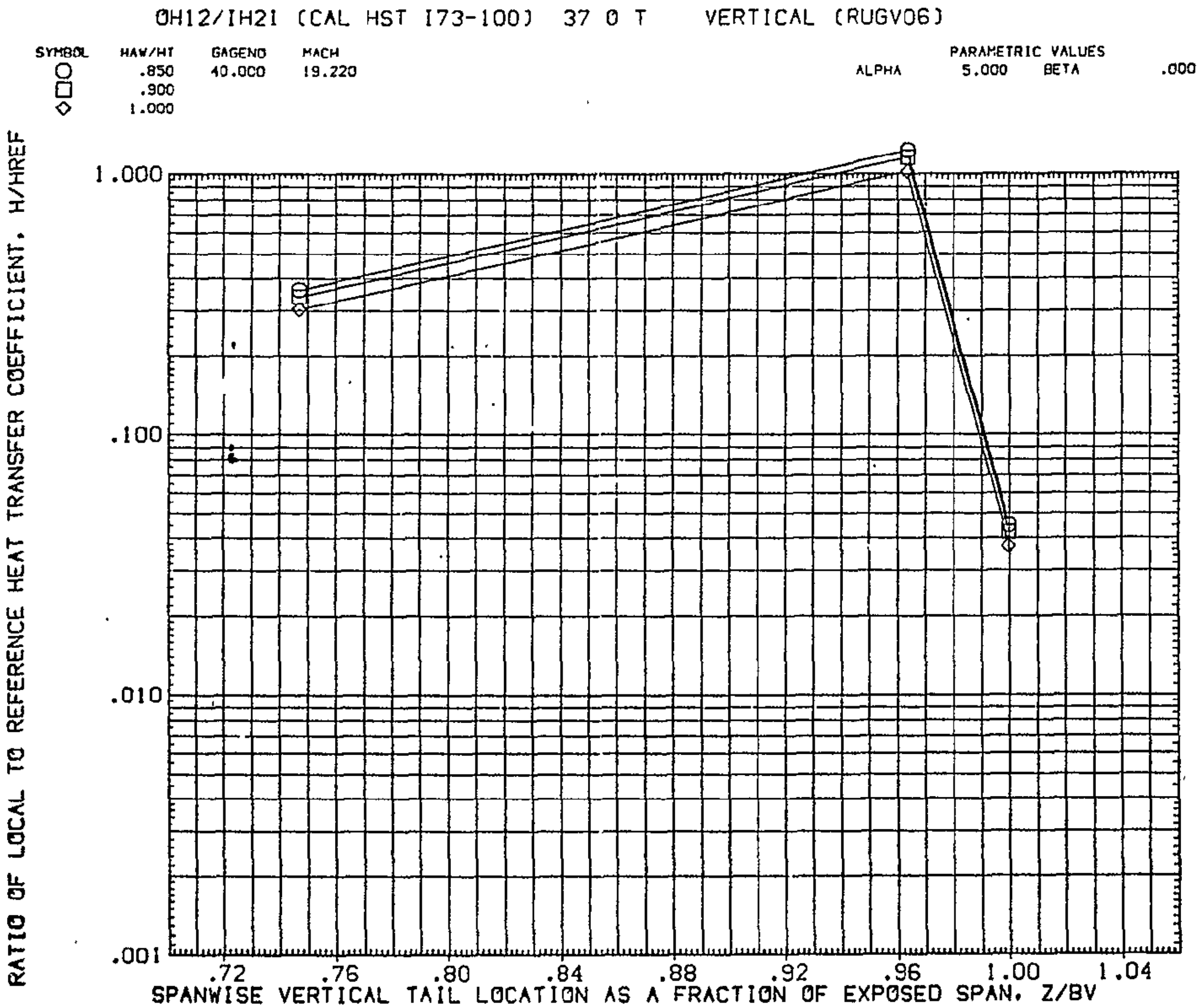

FIG. 13 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 5

OH12 + IH21 MODEL 37 OT(06)/O(08) VERTICAL (IUGV06)

SYMBOL	HAW/HT	GAGENO	MACH
O	.900	40.000	19.170

PARAMETRIC VALUES
ALPHA 5.000 BETA .000

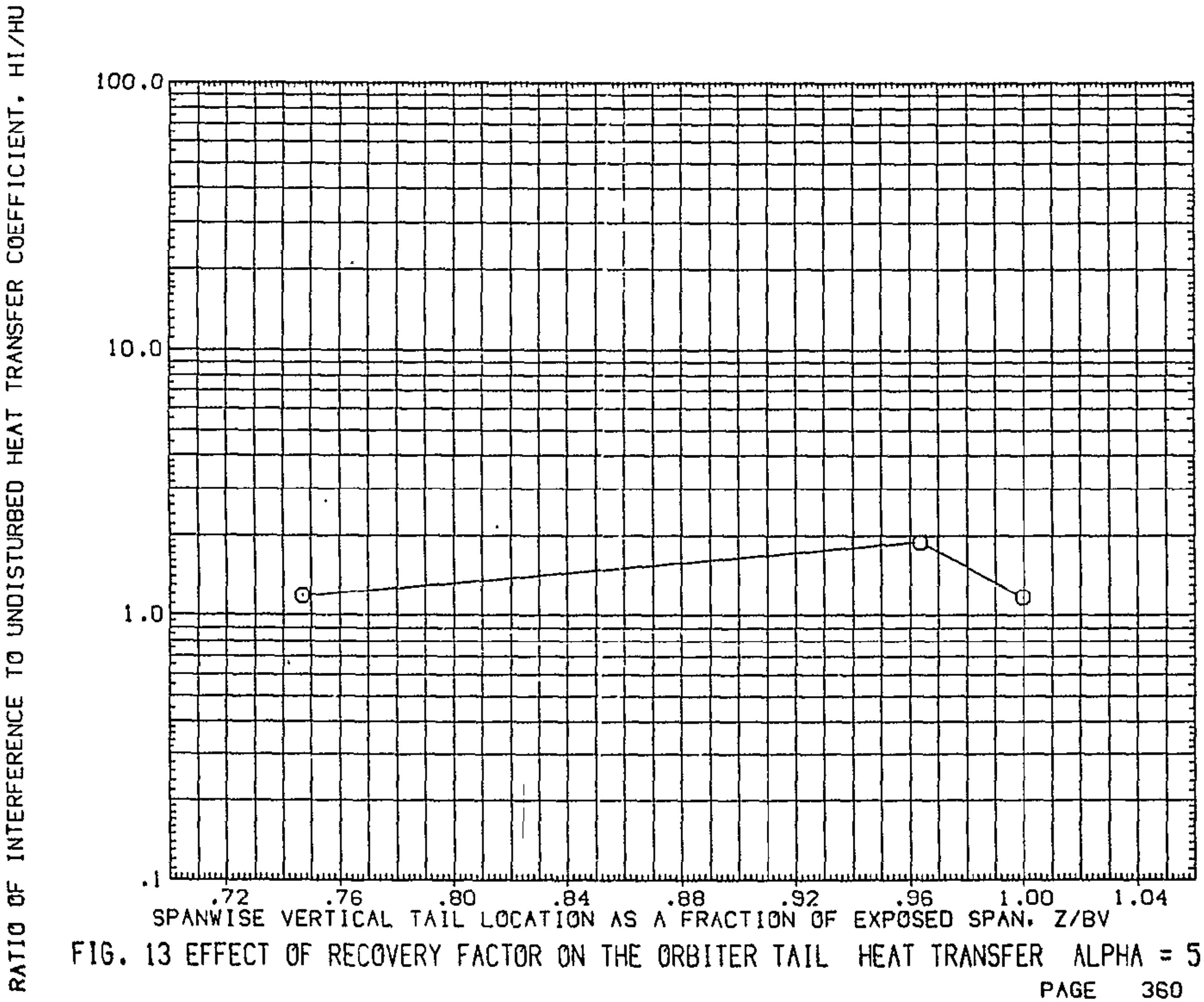

FIG. 13 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 5

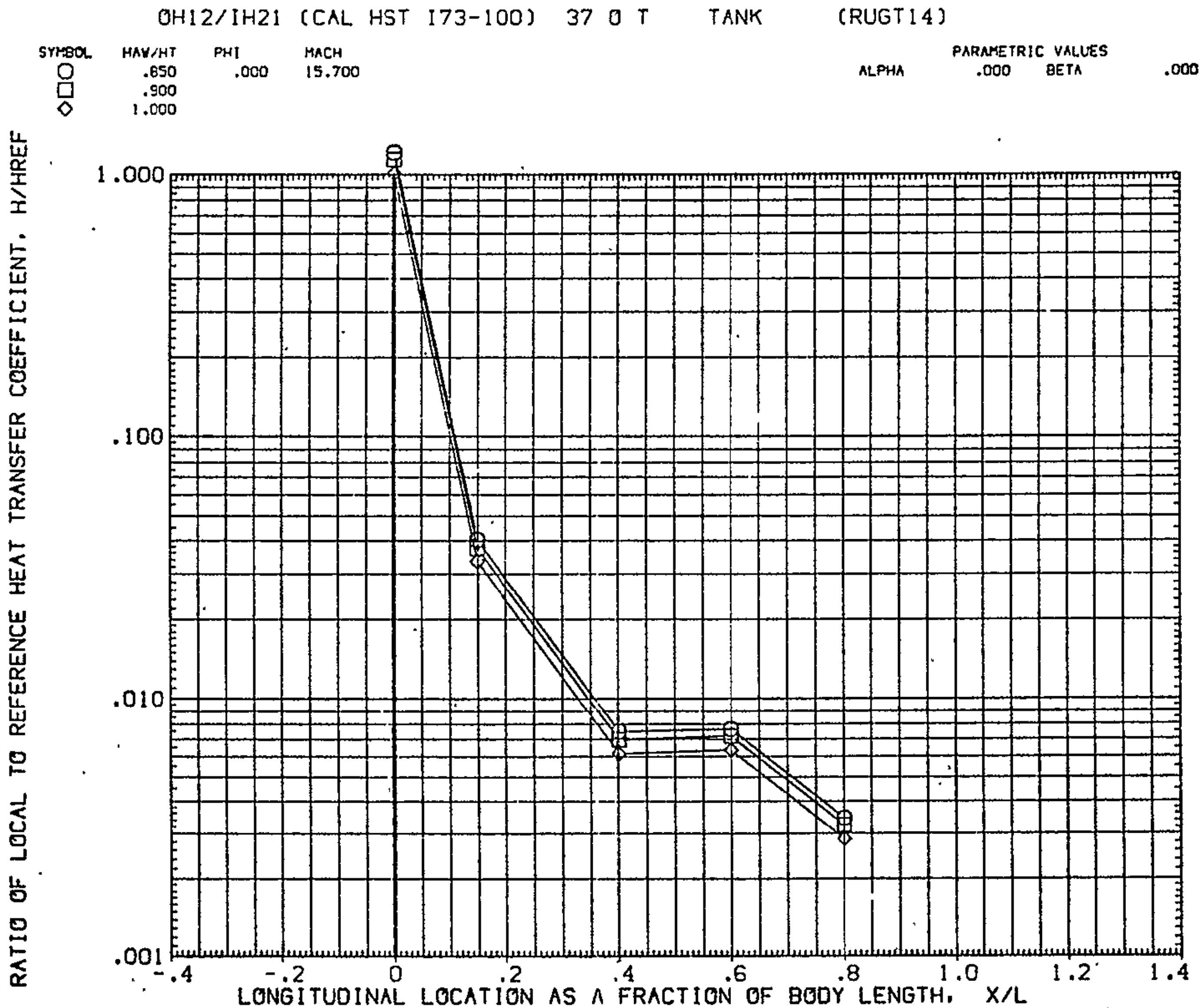

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

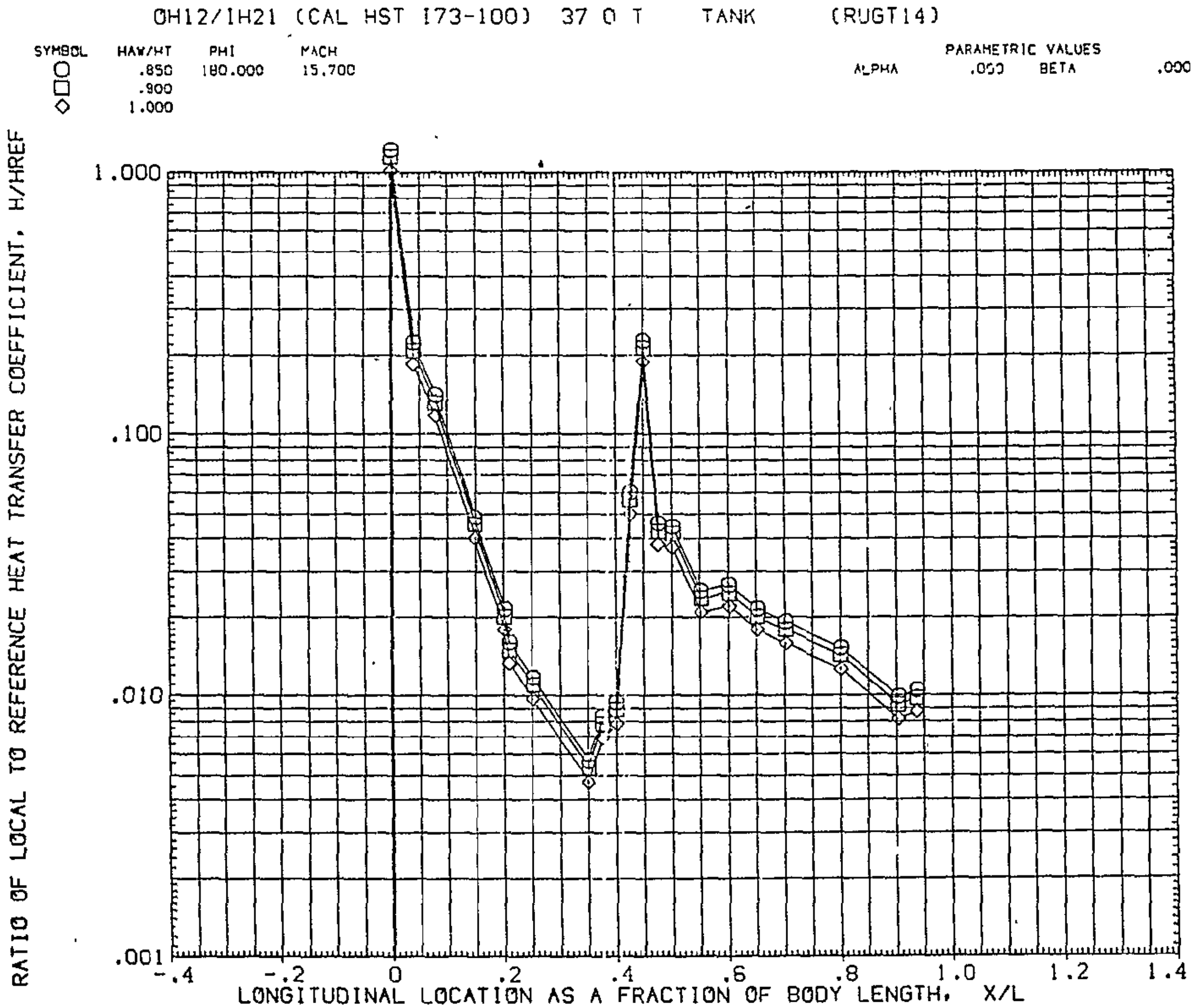

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

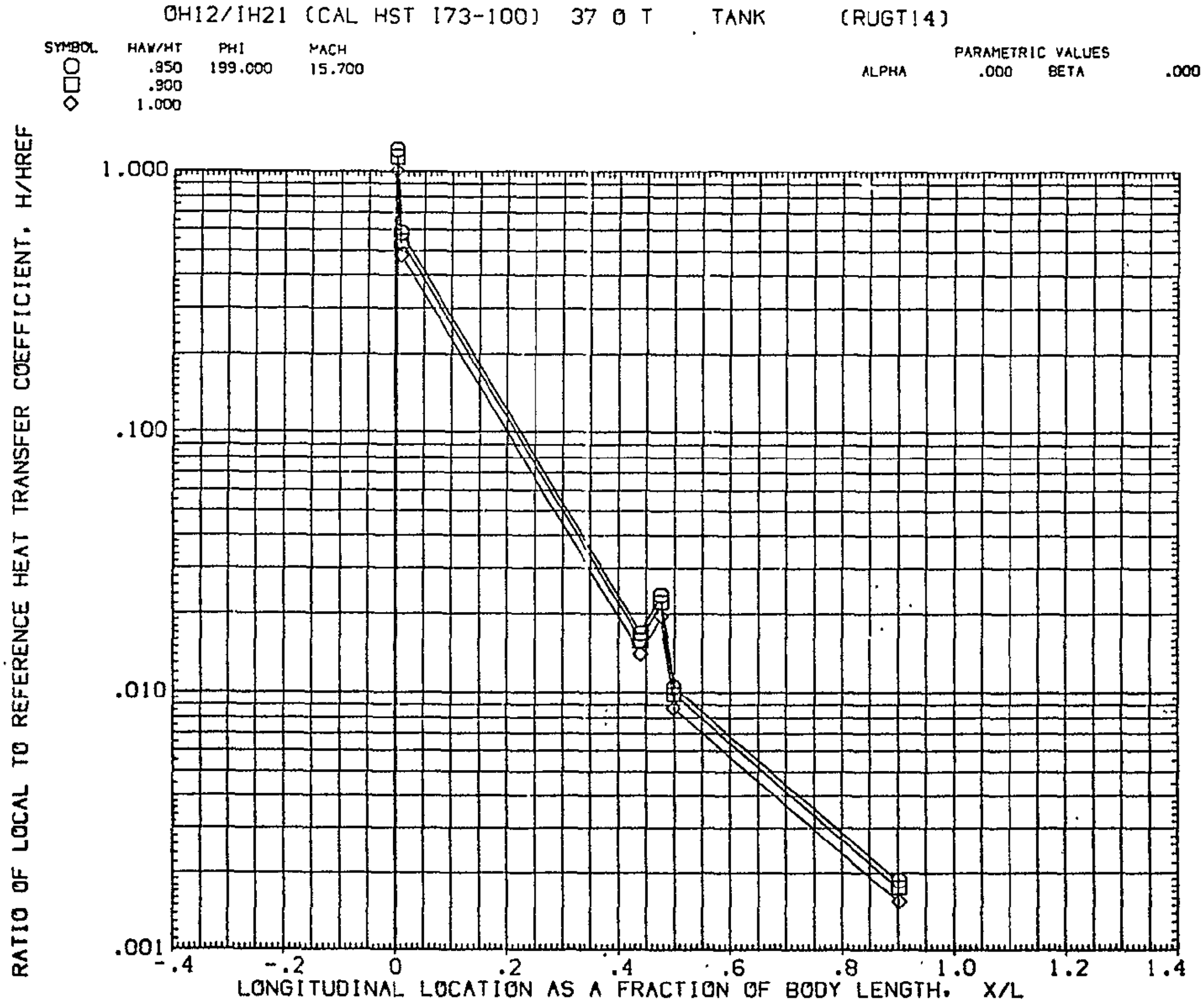

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

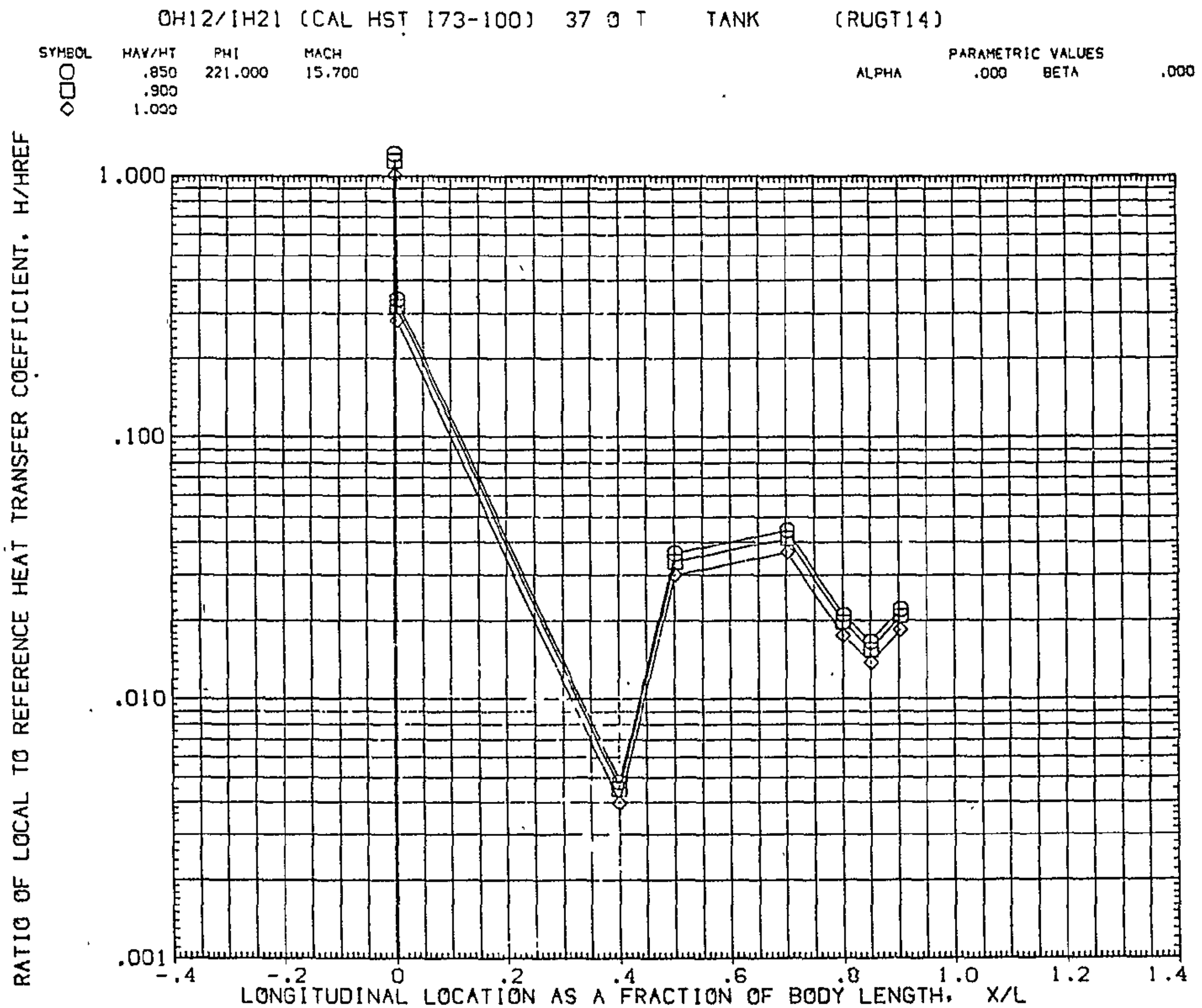

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

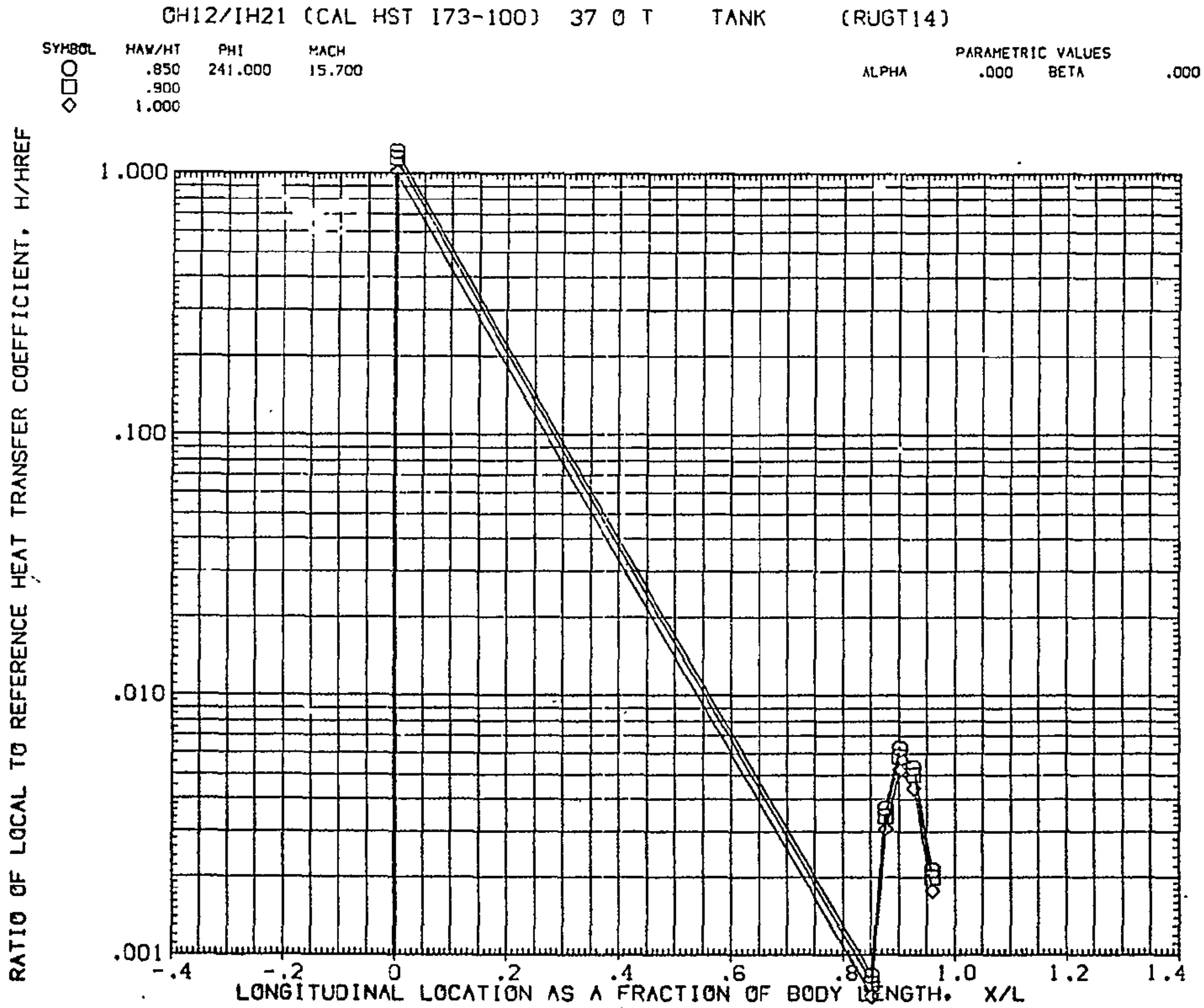

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

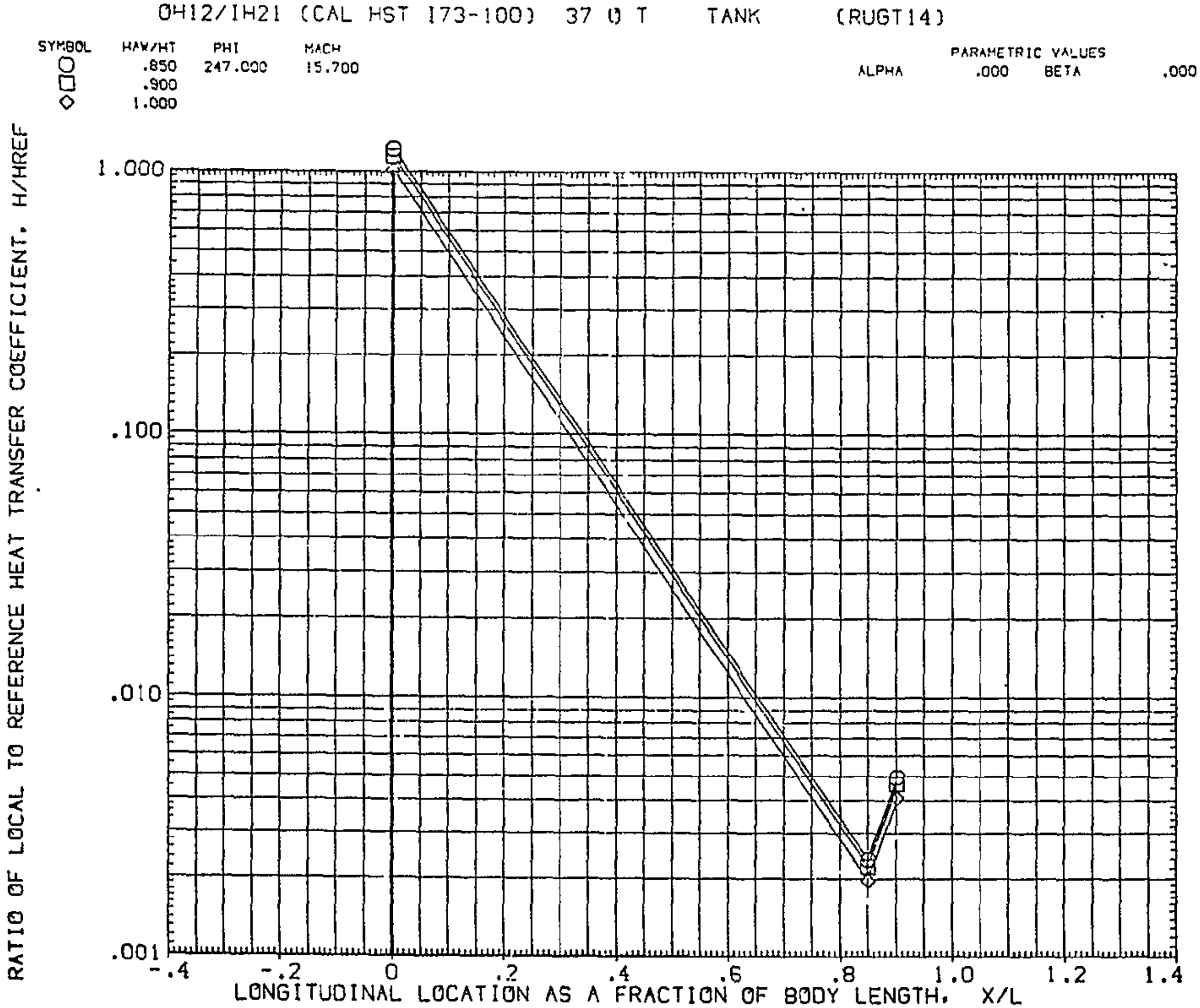

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

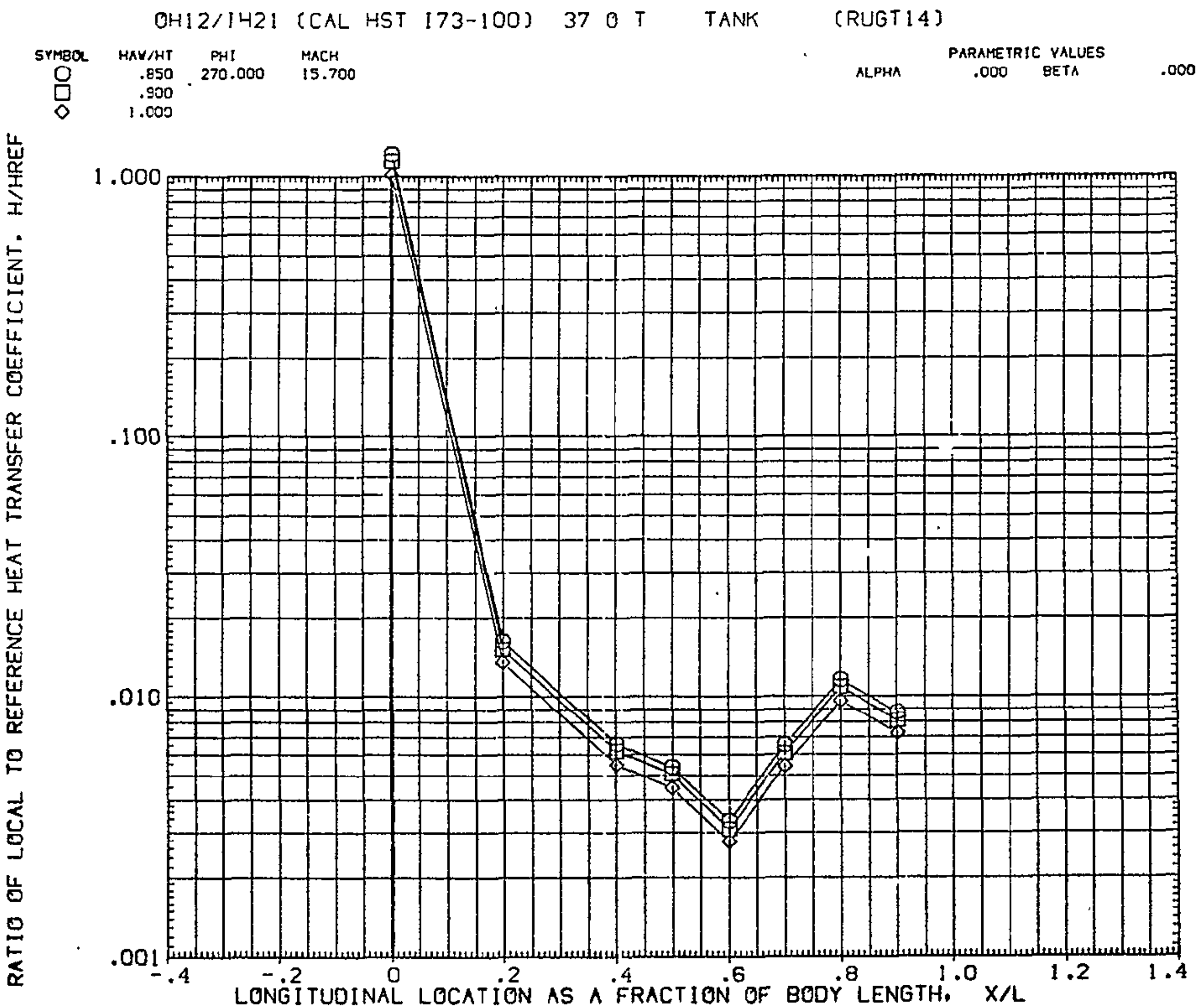

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

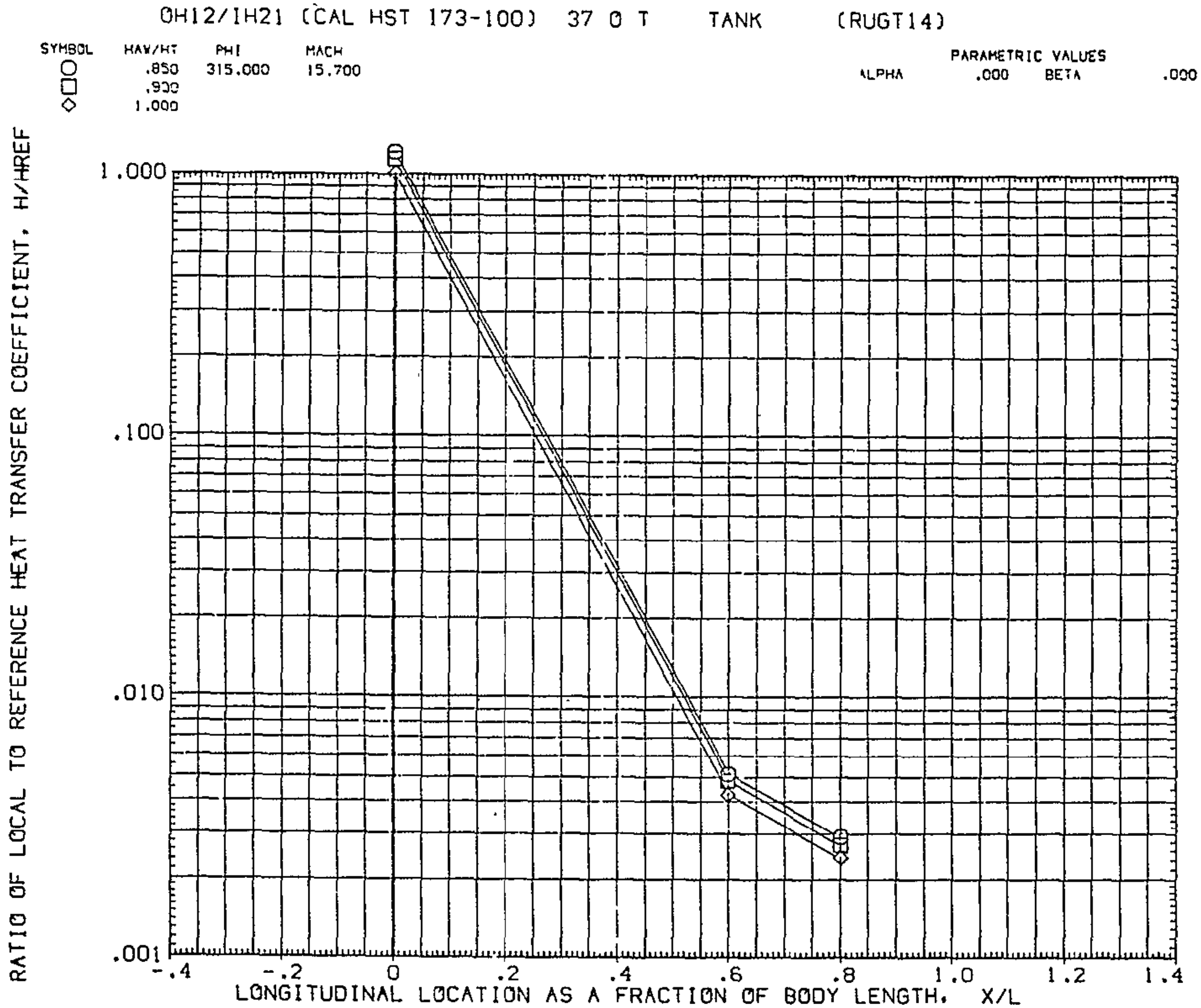

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

0H12/IH21 (CAL HST 173-100) 37 0 T TANK (RUGT14)

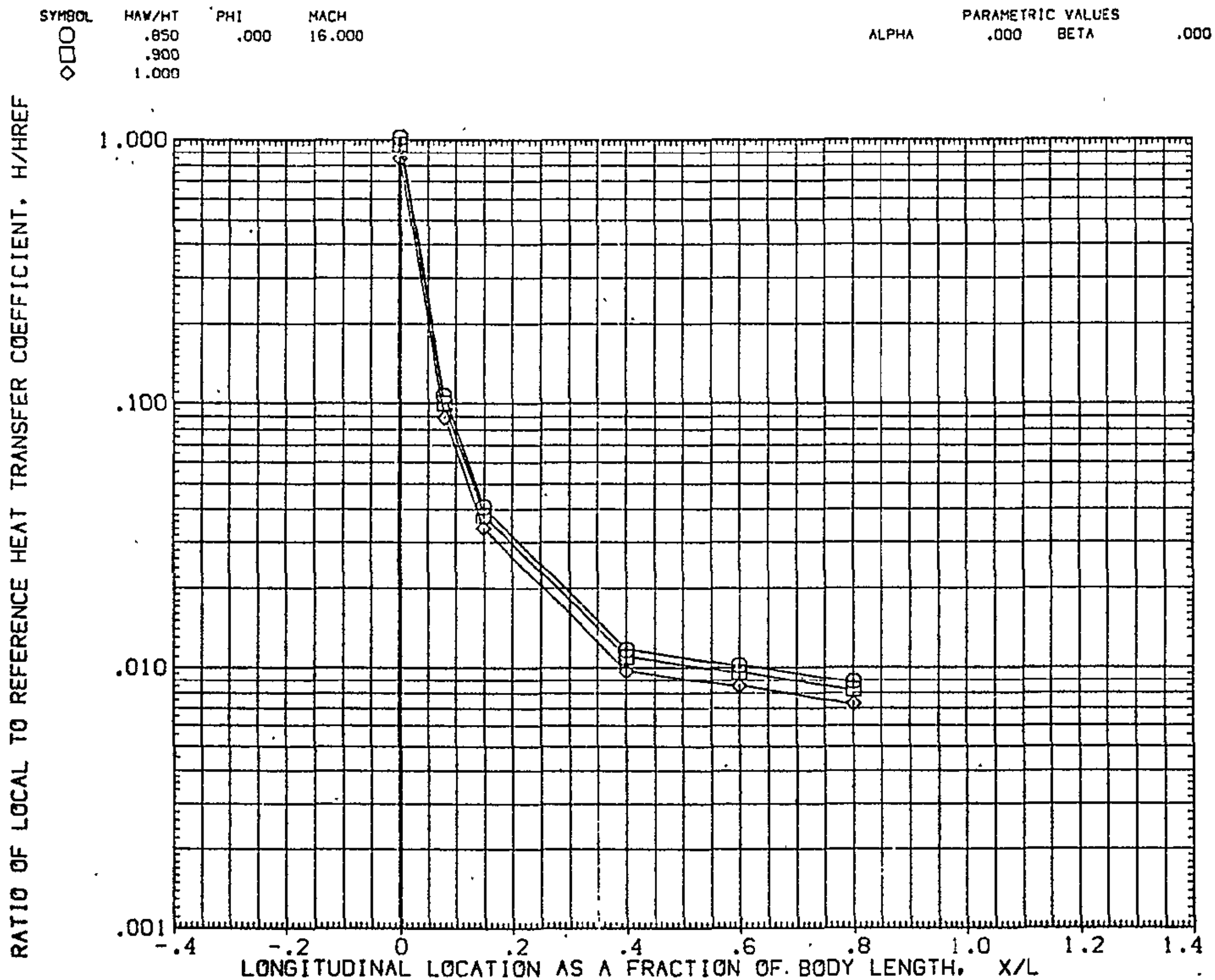

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

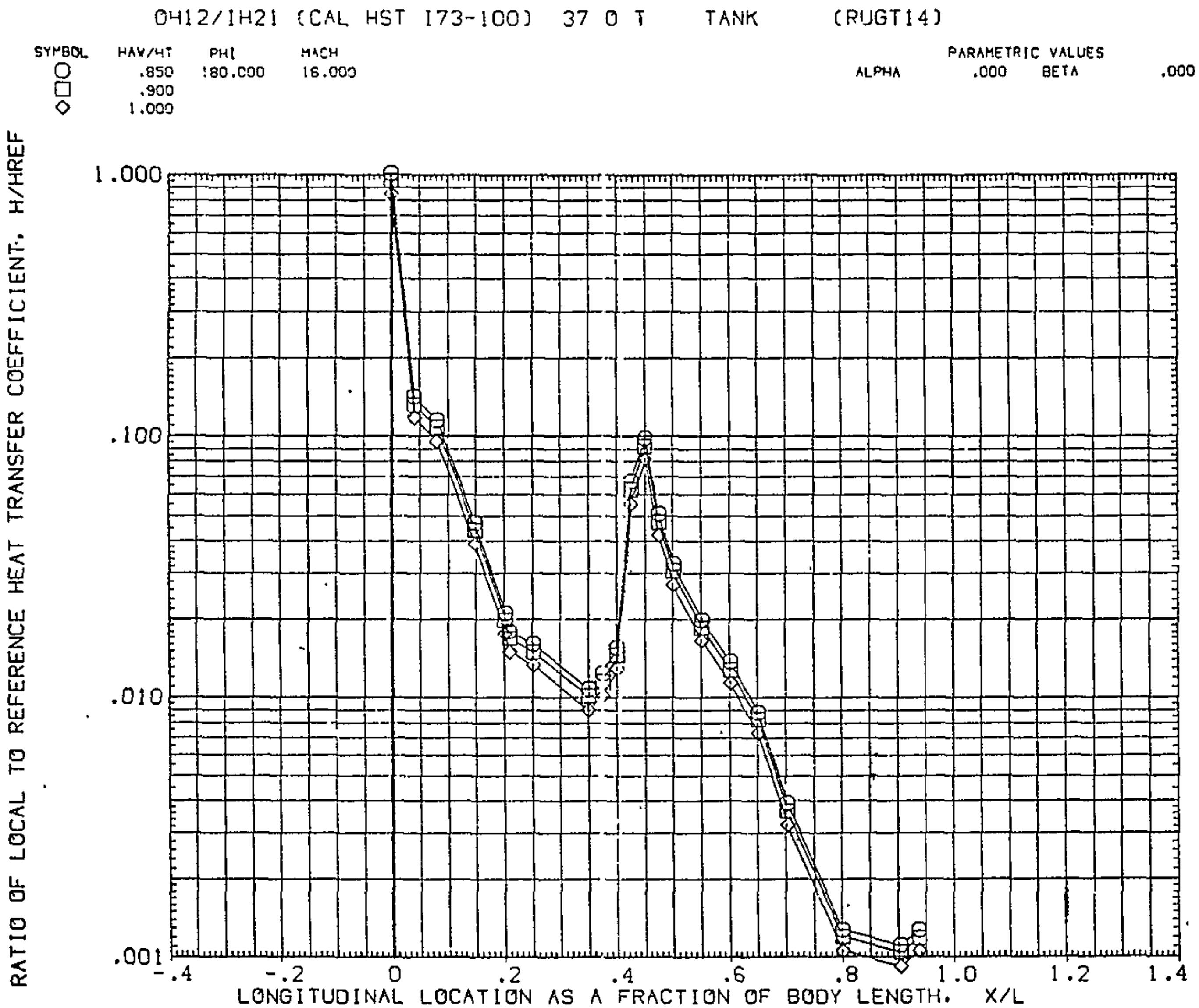

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

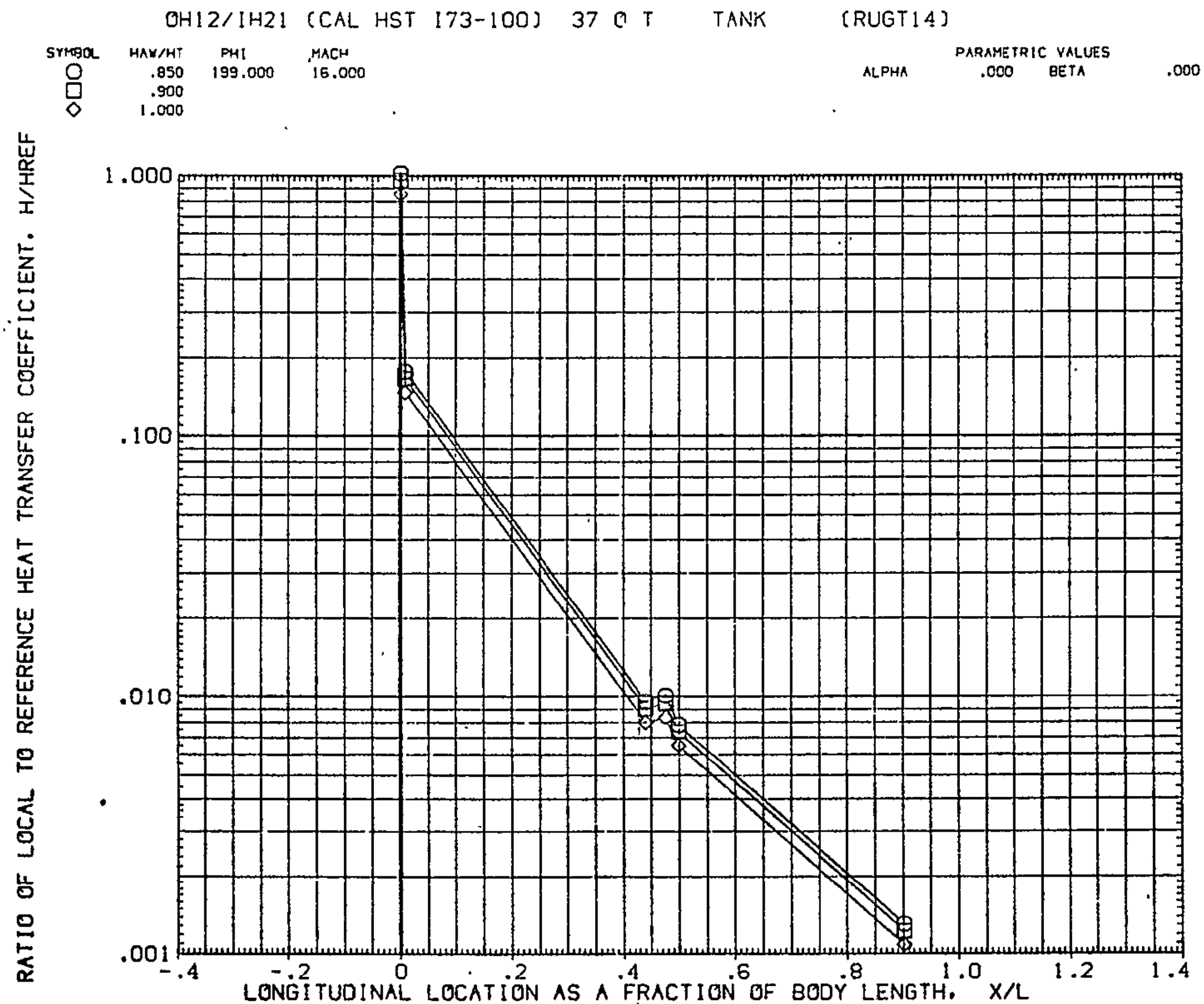

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T TANK (RUGT14)

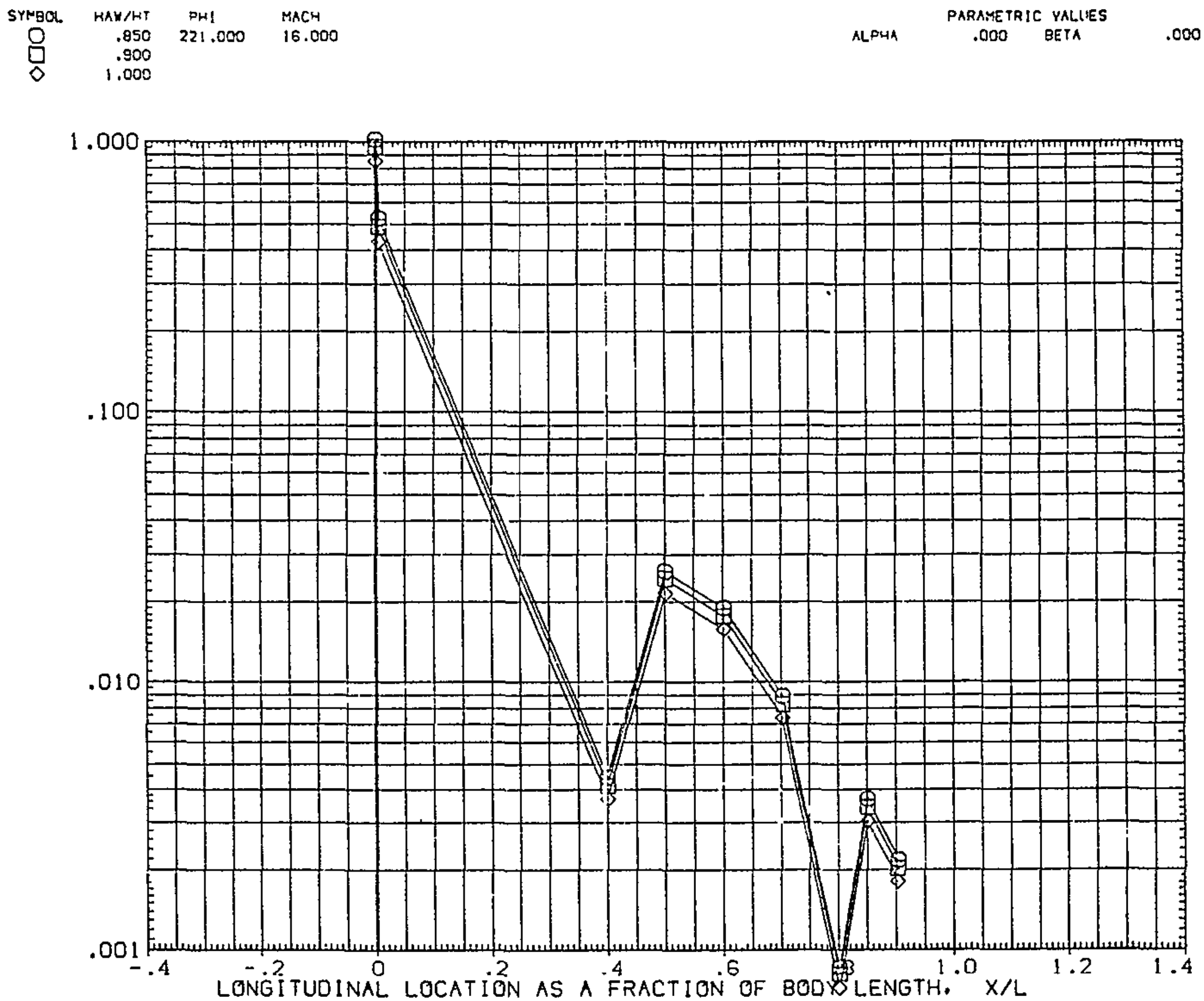

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

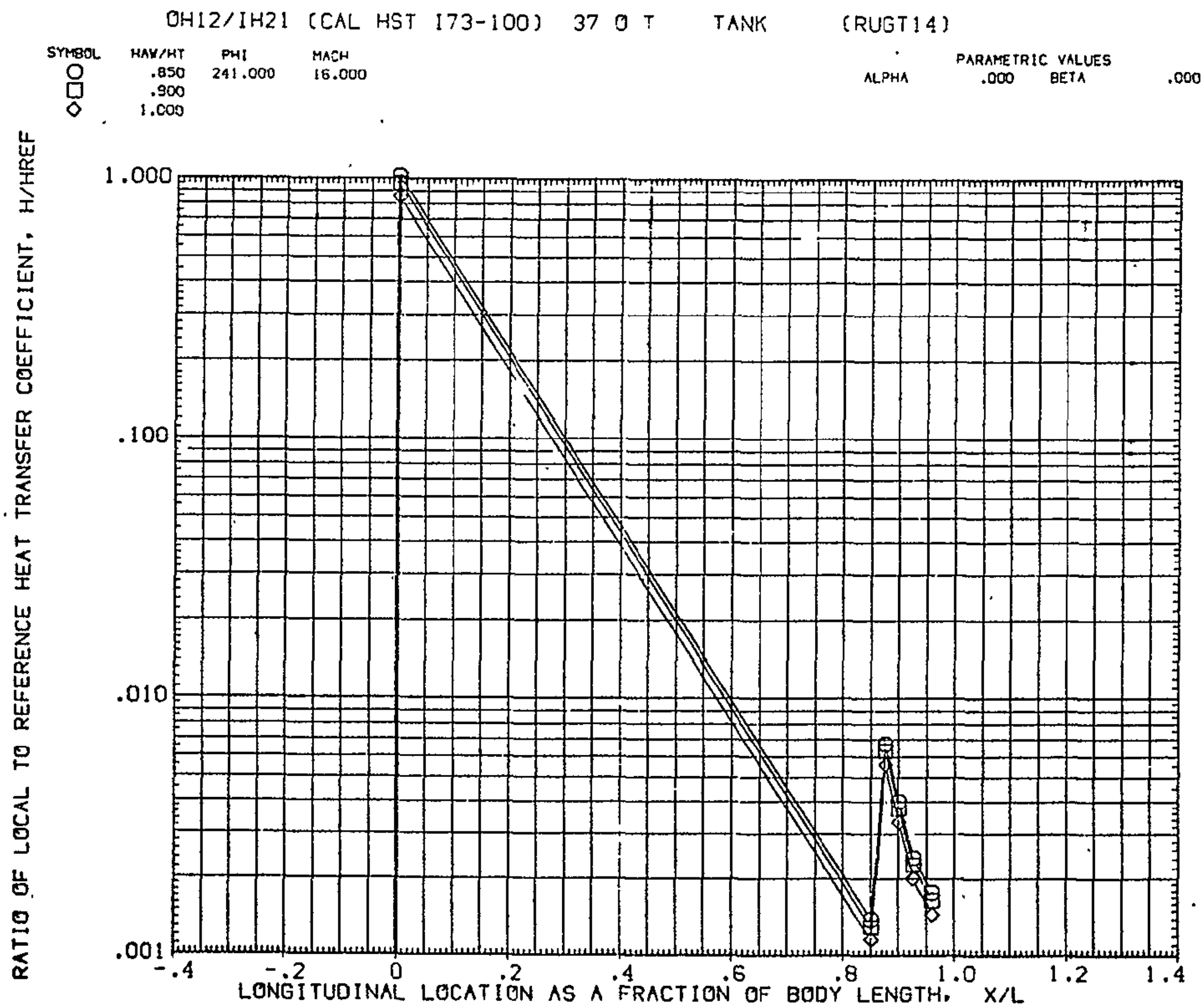

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T TANK (RUGT14)

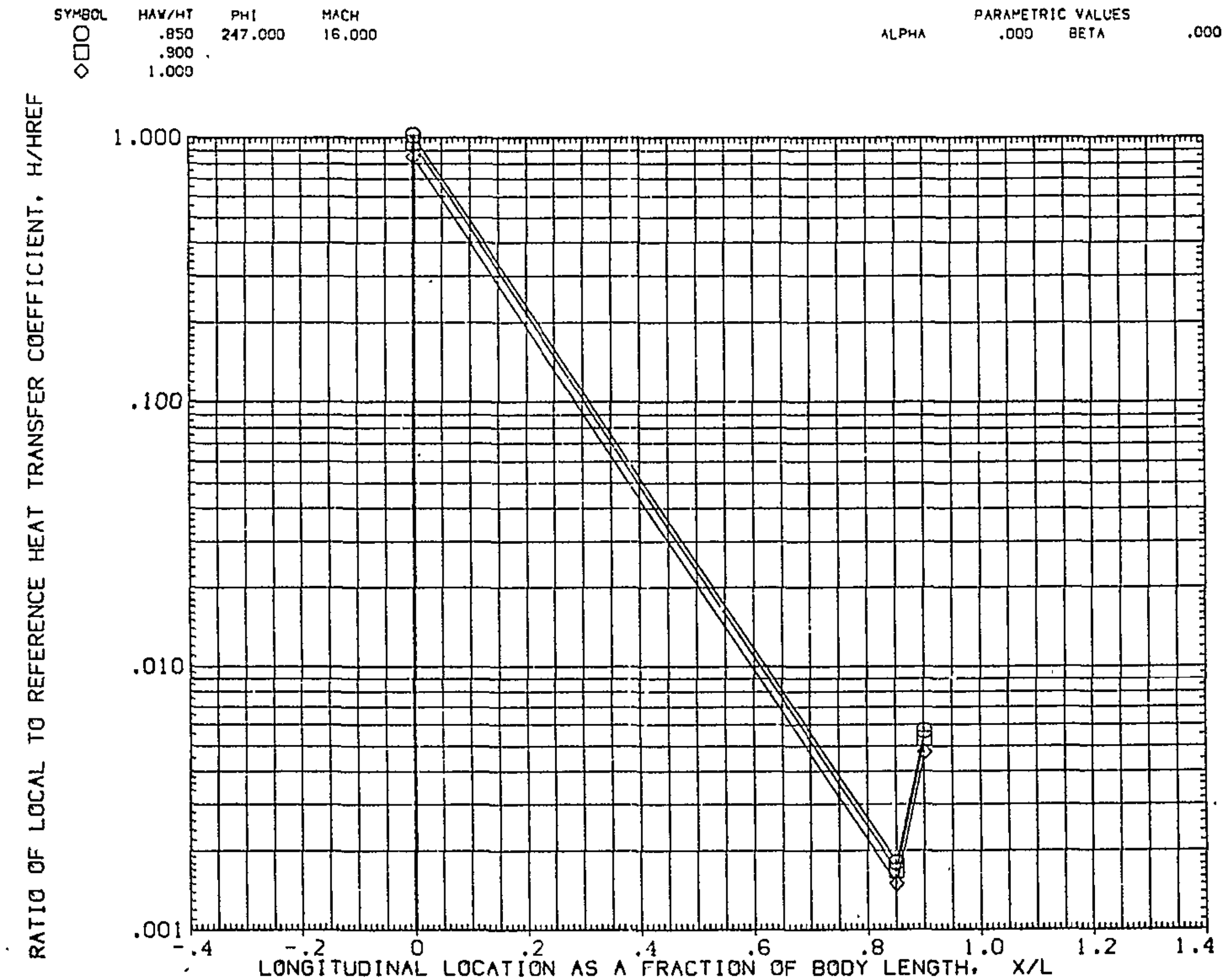

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 O T TANK (RUGT14)

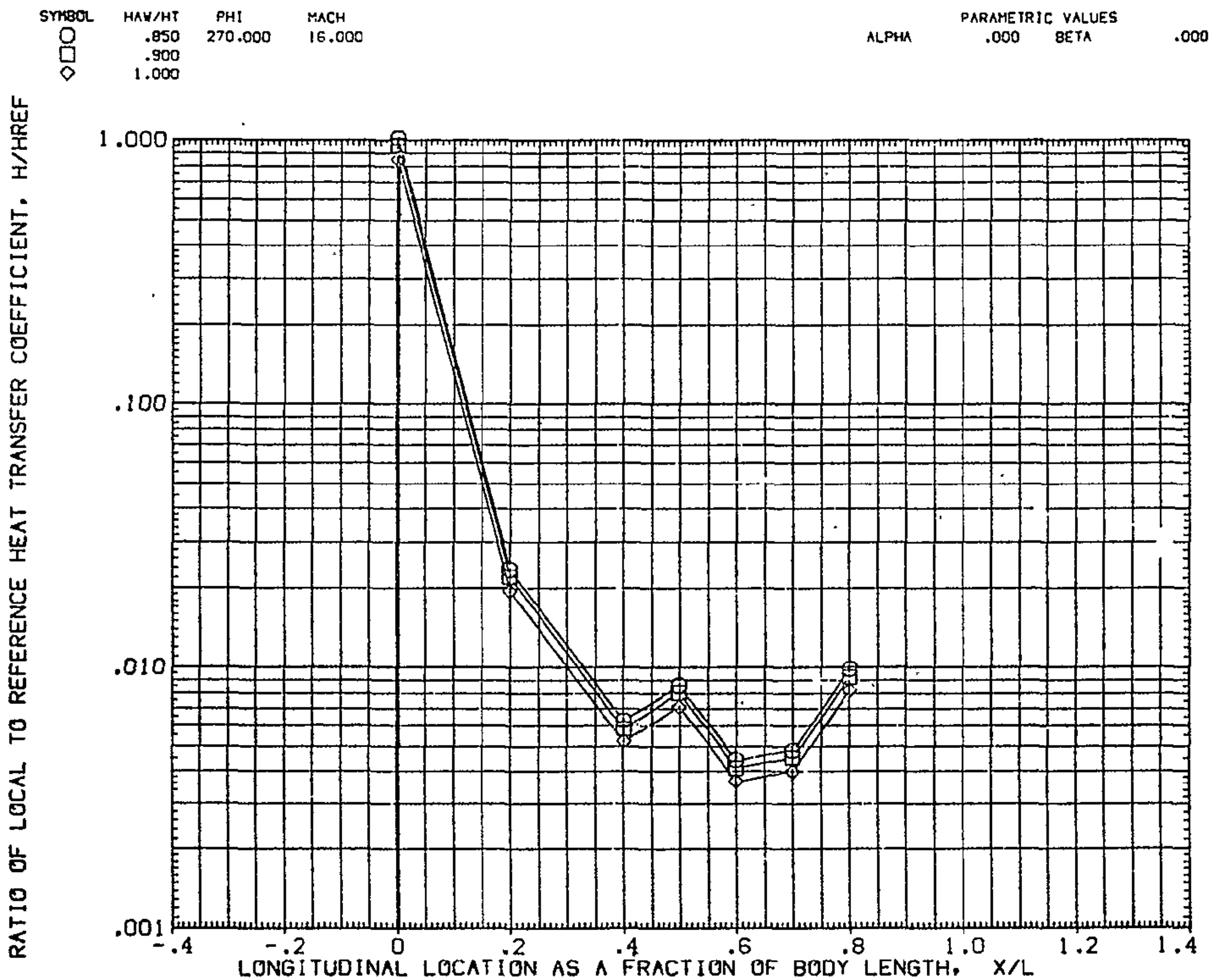

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T TANK (RUGT14)

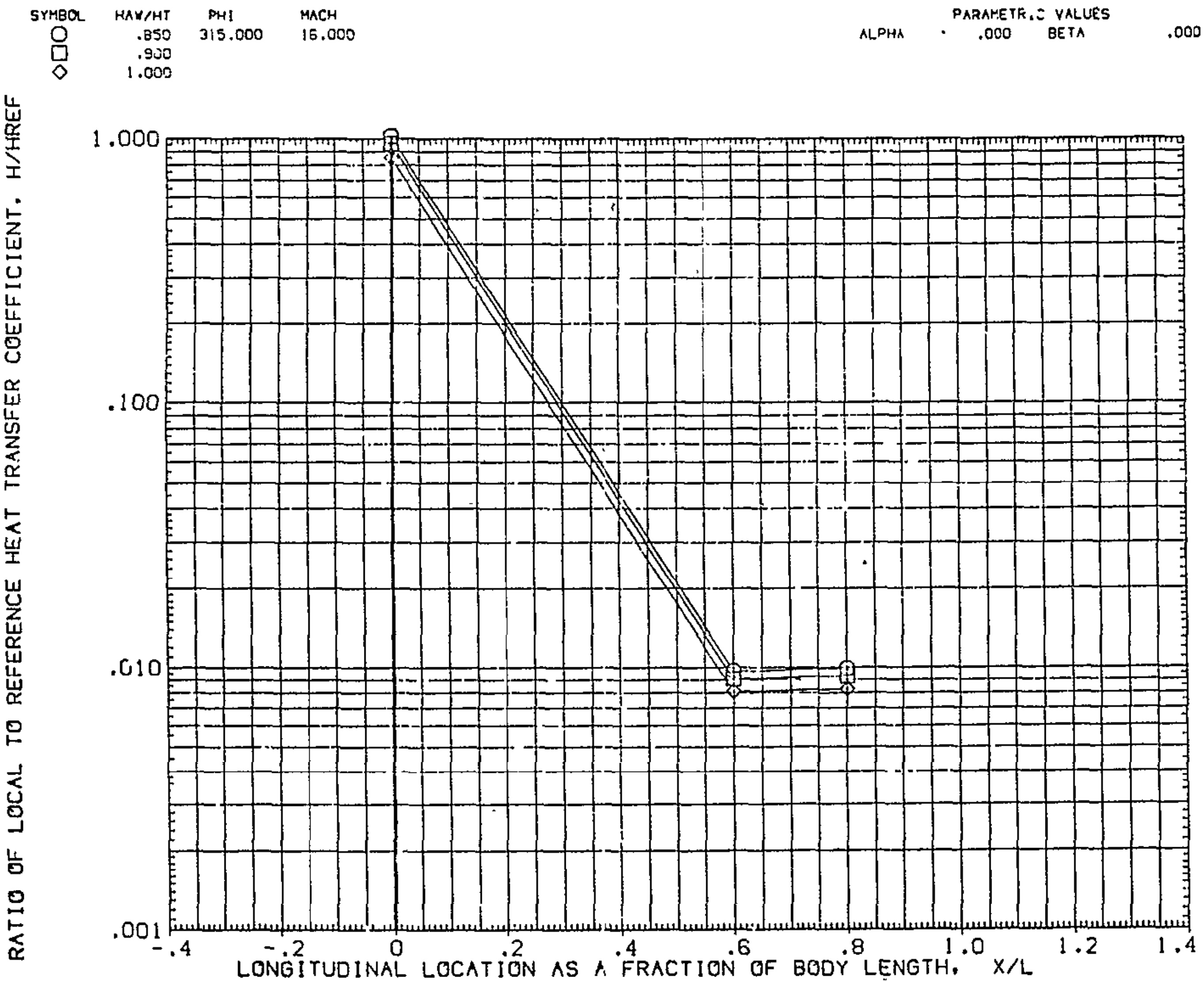

FIG. 14 EFFECT OF RECOVERY FACTOR ON THE E. TANK HEAT TRANSFER RN/L2 ALPHA = 0

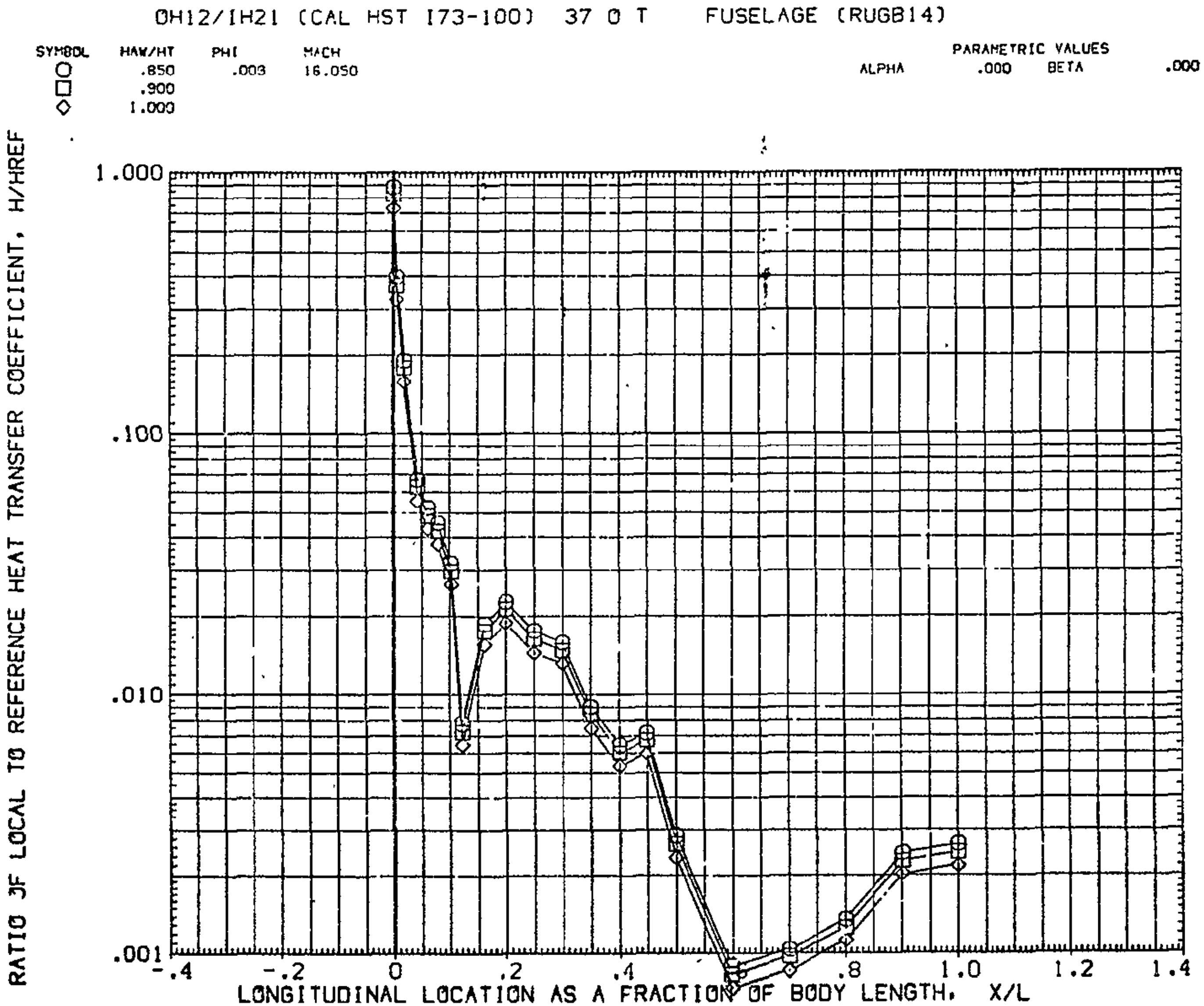

FIG. 15 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

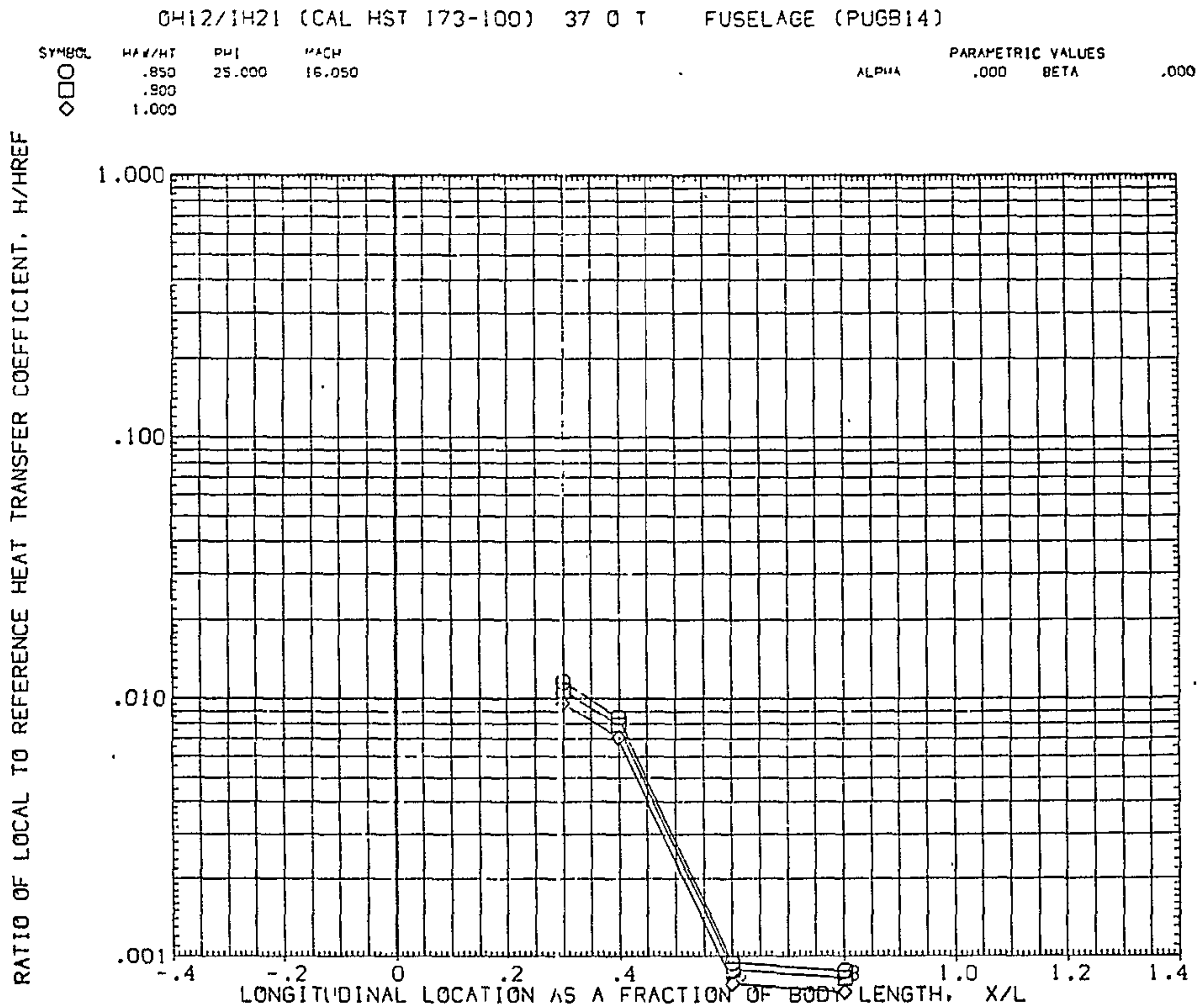

FIG. 15 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T FUSELAGE (RUGB14)

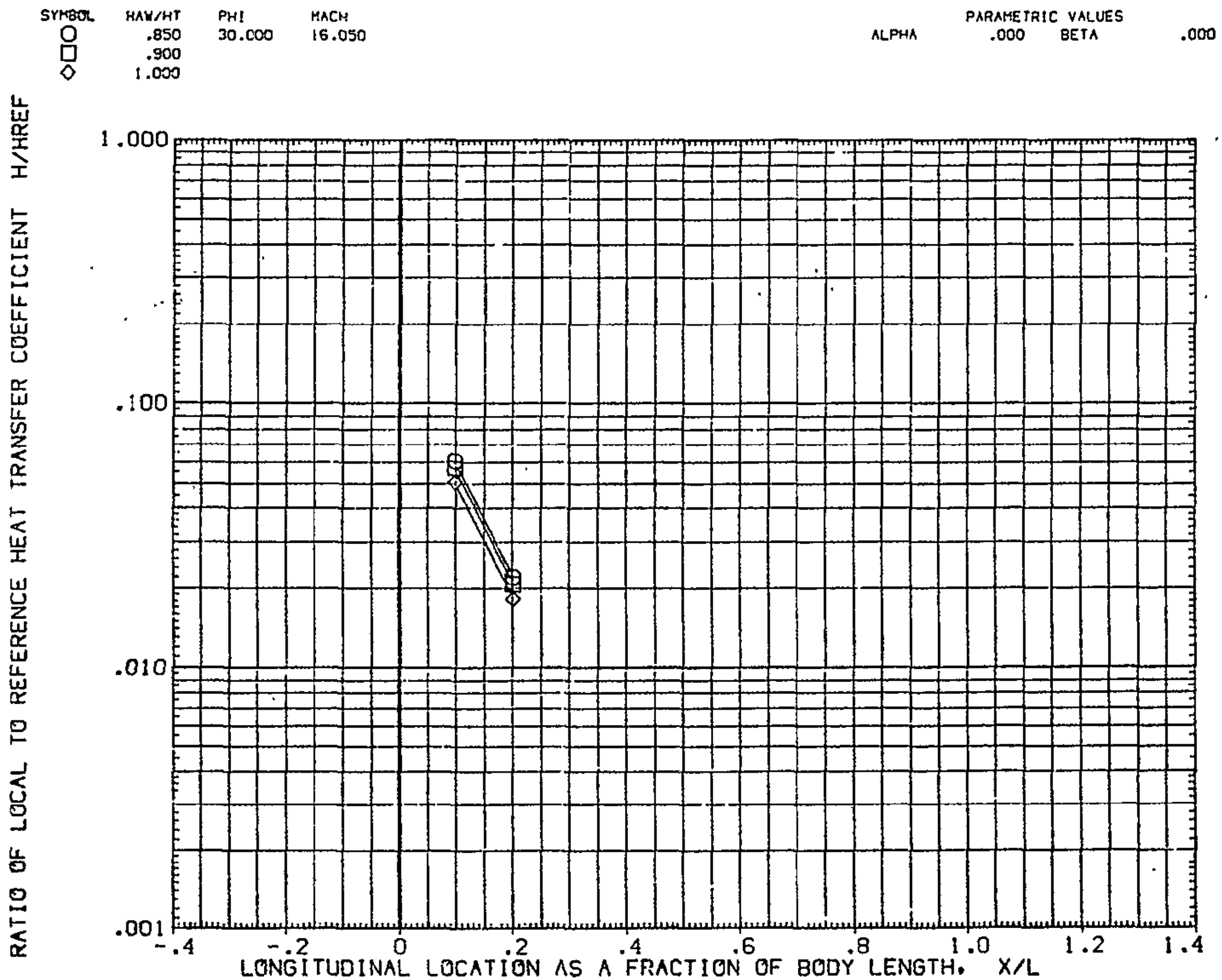

FIG. 15 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

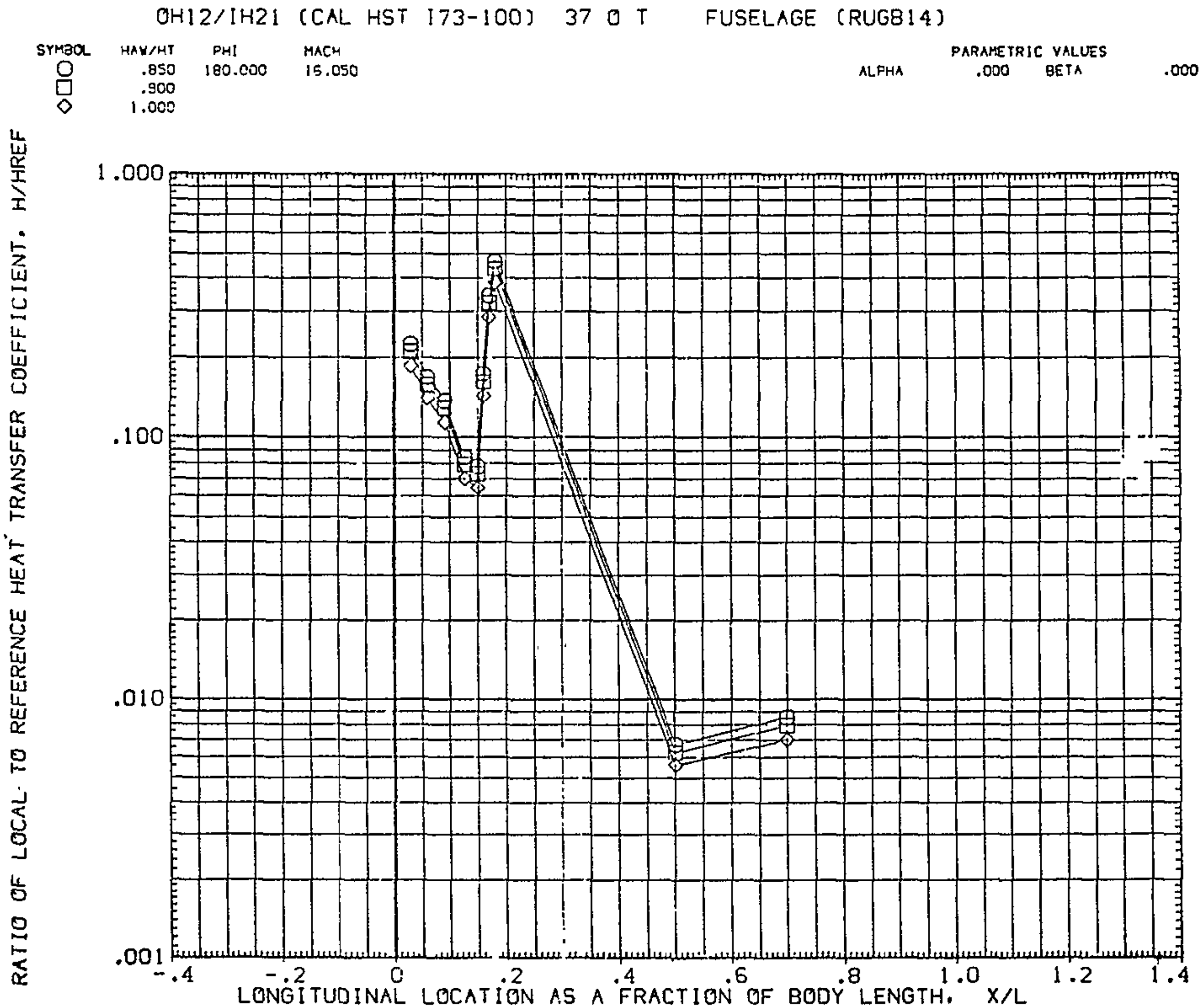

FIG. 15 EFFECT OF RECOVERY FACTOR ON THE ORBITER BODY HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T WING L.S.(RUGW14)

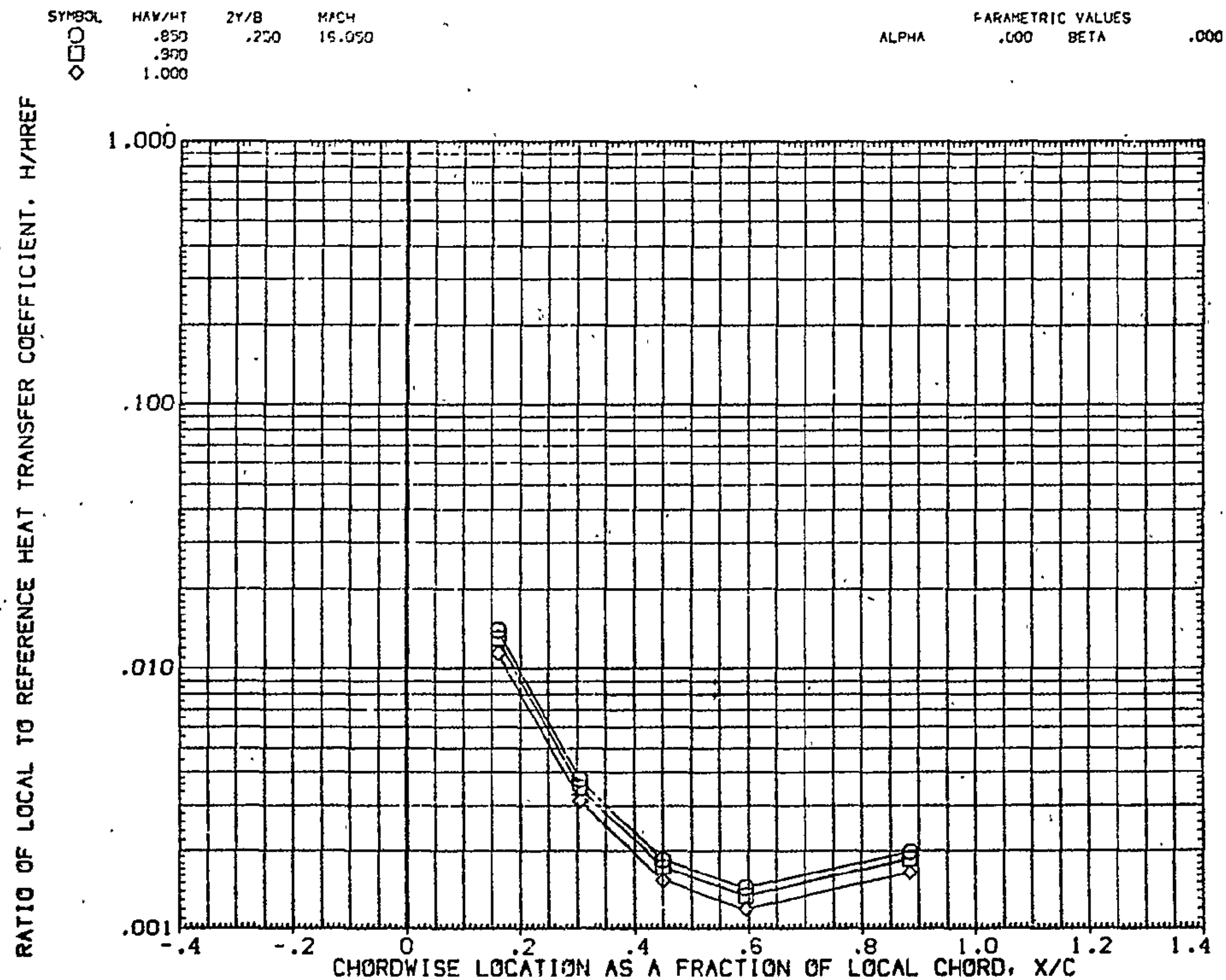

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

ØH12/IH21 (CAL HST 173-100) 37 0 T WING L.S.(RUGW14)

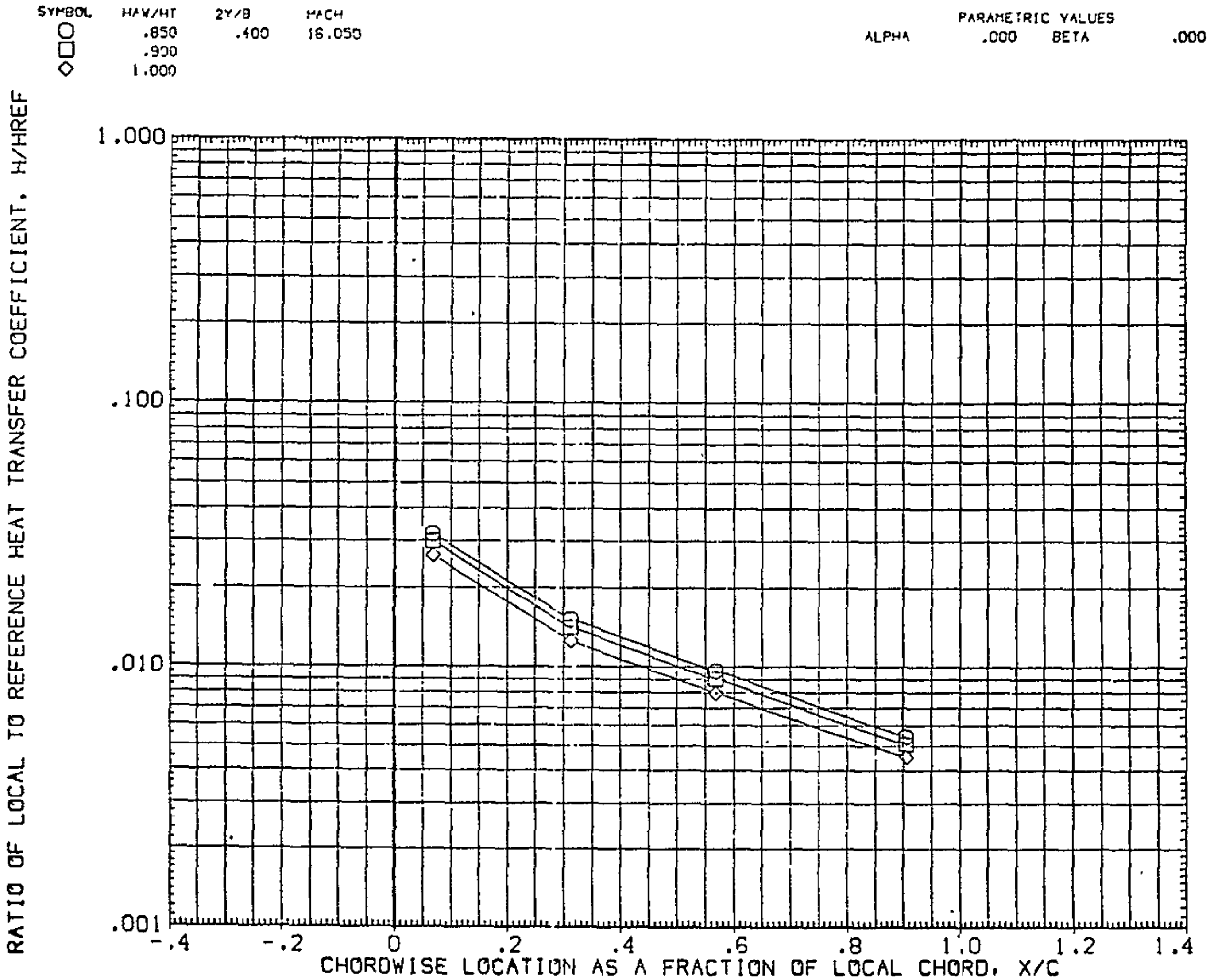

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST 173-100) 37 0 T   WING L.S.(RUGW14)

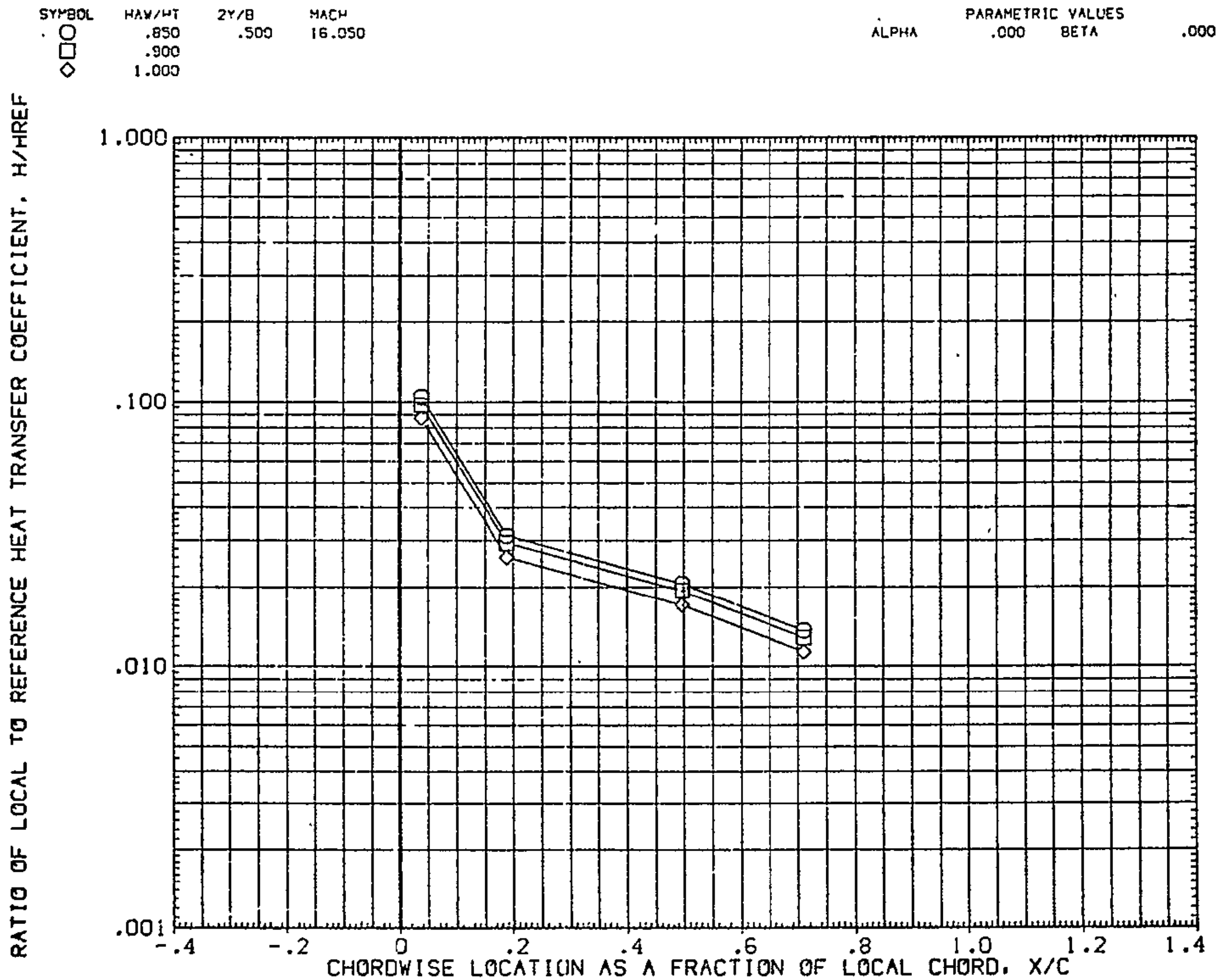

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

0H12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW14)

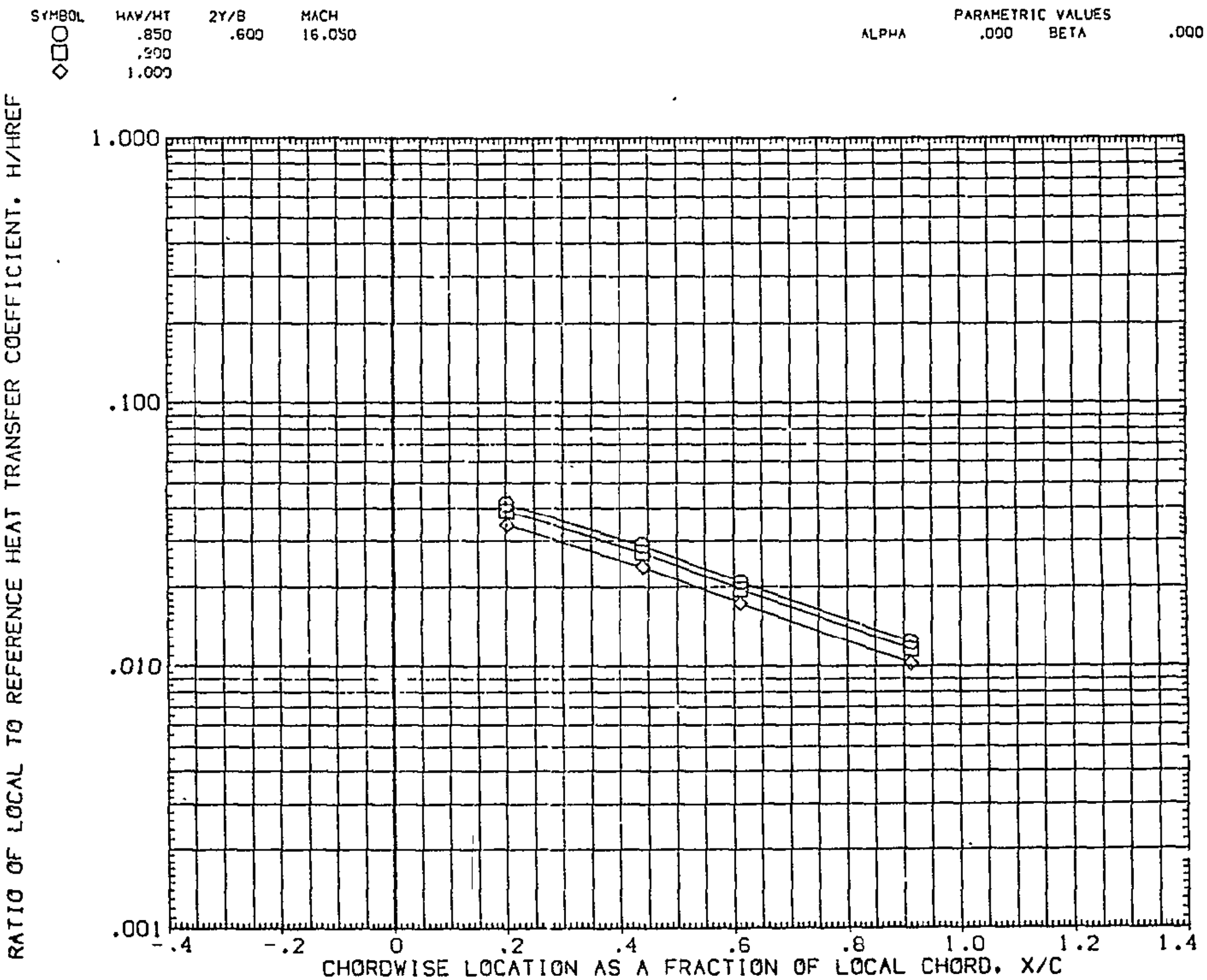

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

OH12/IH21 (CAL HST I73-100) 37 0 T WING L.S.(RUGW14)

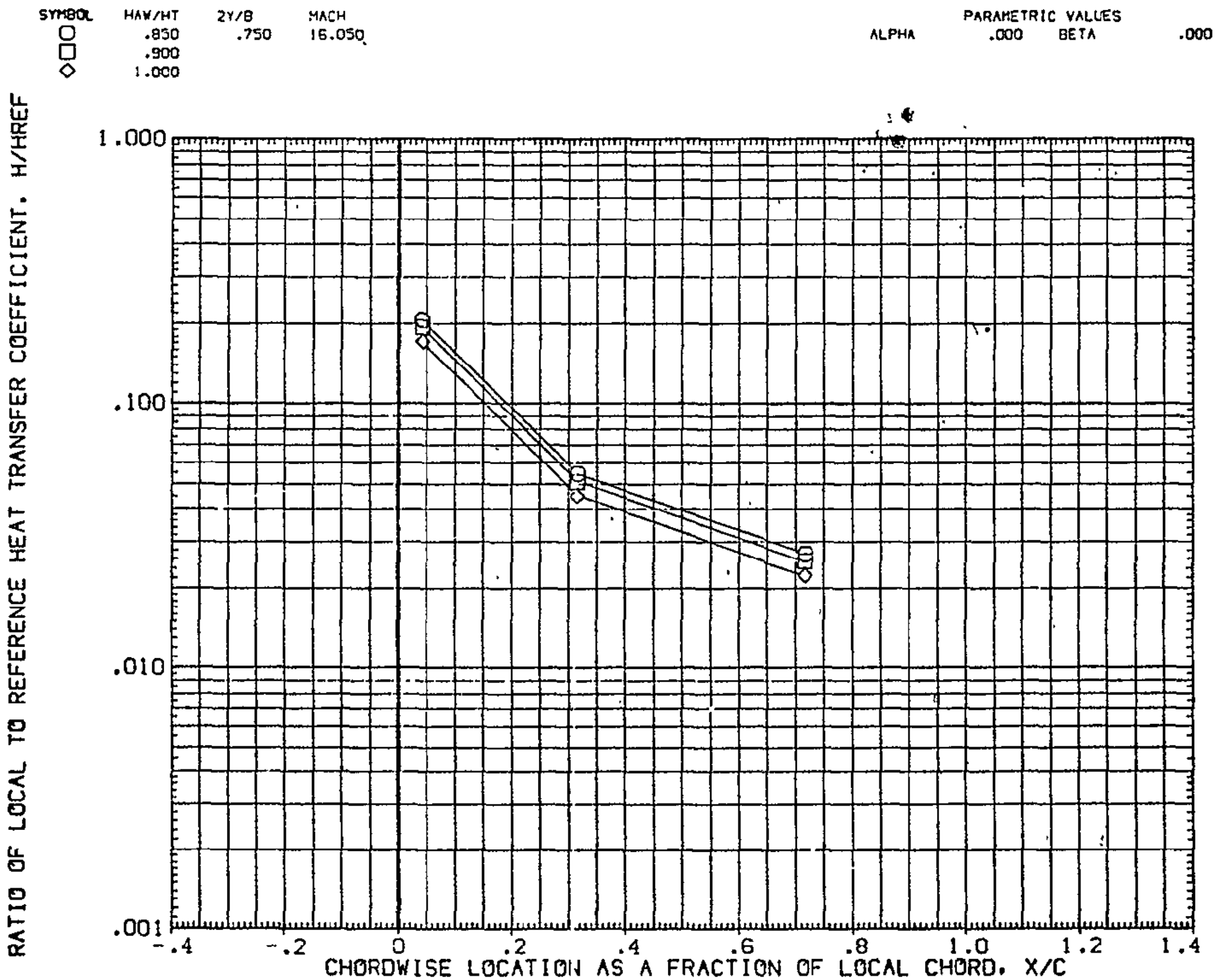

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

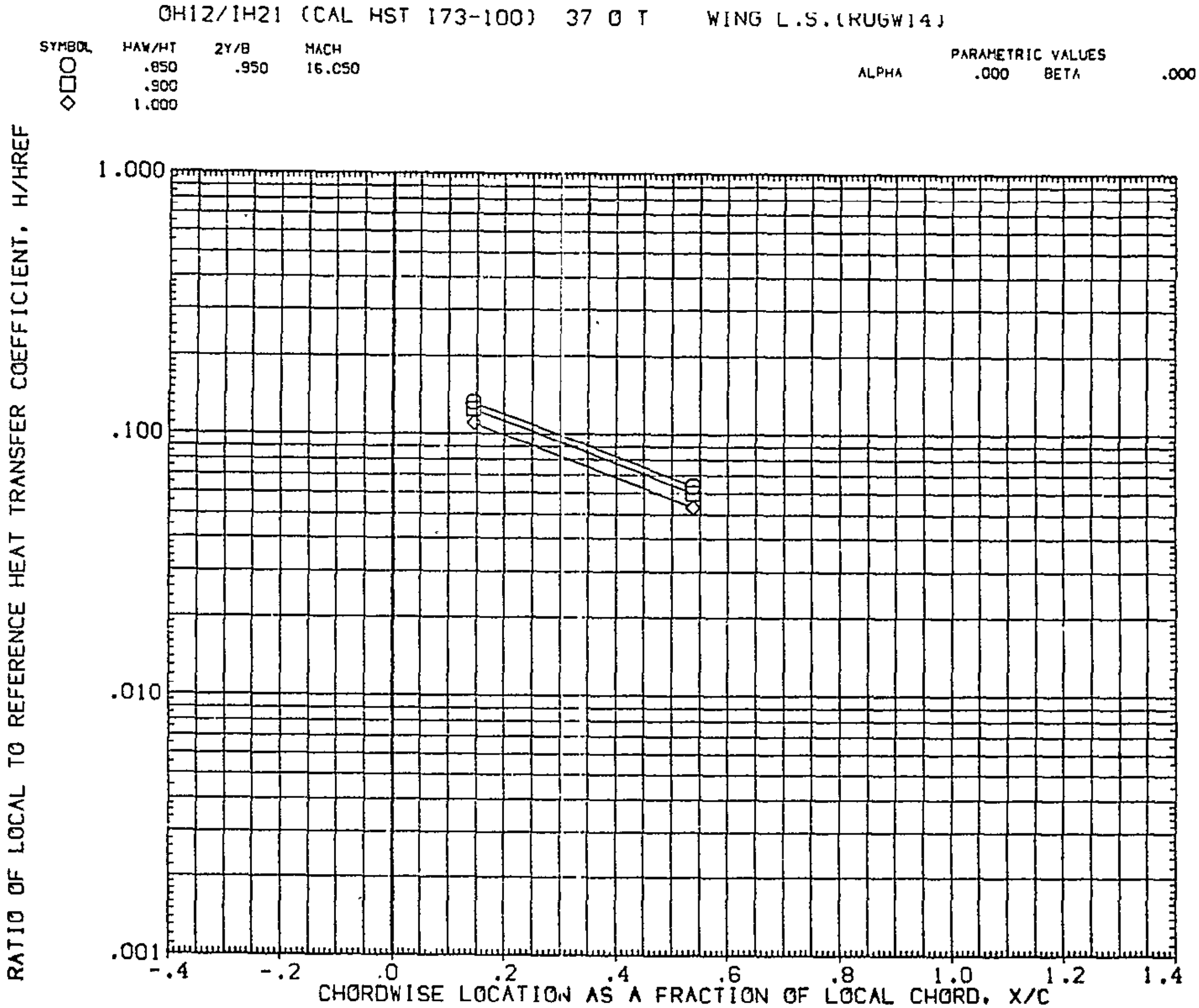

FIG. 16 EFFECT OF RECOVERY FACTOR ON THE ORBITER WING HEAT TRANSFER ALPHA = 0

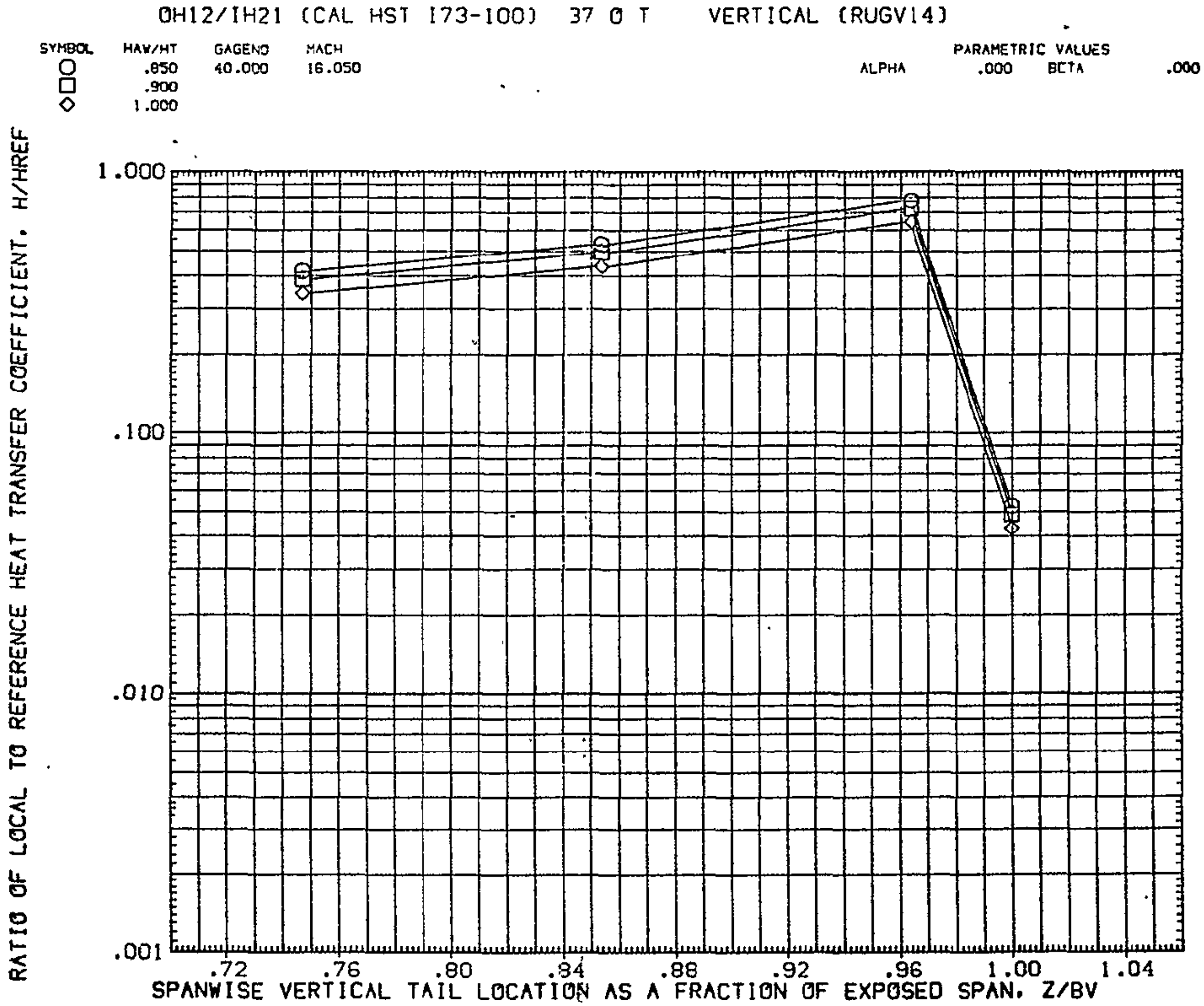

FIG. 17 EFFECT OF RECOVERY FACTOR ON THE ORBITER TAIL HEAT TRANSFER ALPHA = 0